35th Congress, 2d Session. } SENATE. { Ex. Doc. No. 14.

REPORT

THE SUPERINTENDENT

OF THE

COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1858.

WASHINGTON:
WILLIAM A. HARRIS, PRINTER.
1859.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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LETTER

OF THE

SECRETARY OF THE TREASURY,

COMMUNICATING

The Report of the Superintendent of the Coast Survey for the year ending November 1, 1858.

JANUARY 10, 1859.—Read.

FEBRUARY 18, 1859.—*Resolved,* That there be printed, in addition to the usual number, five thousand copies of the report of the Superintendent of the Coast Survey for the year 1858, for distribution by said Superintendent; that the same be printed and bound with the charts and sketches in quarto form, and that the printing of said charts and sketches be done to the satisfaction of the Superintendent of the Coast Survey.

TREASURY DEPARTMENT,
January 4, 1859.

SIR: I have the honor to present, for the information of the Senate, a report made to the Department by Professor A. D. Bache, Superintendent of the United States Coast Survey, showing the progress of the work during the year ending November 1, 1858, and the accompanying map, prepared at the Coast Survey Office, in accordance with an act of Congress approved March 3, 1853.

This report was submitted to me in December last, and would have been transmitted then, in accordance with the law, but for the adjournment of Congress before the close of that month.

With great respect, your obedient servant,

HOWELL COBB,
Secretary of the Treasury.

Hon. J. C. BRECKINRIDGE,
Vice President of the United States and President of the United States Senate.

ABSTRACT OF CONTENTS OF REPORT.

CONTENTS OF APPENDIX.

I.—FIELD, HYDROGRAPHIC, AND OFFICE DETAILS.

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ALPHABETICAL INDEX.

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ERRATA

In Coast Survey Report for 1857.

Page 111: Line 15, for 1889 read 18 sq. m.

Page 226: Lines 19 and 29, for Lynn read Lyme.

Page 272: Line 37, for 40° 56′ 06″.88 read 40° 56′ 06″.38.

Page 272: Line 8 from bottom, for 40° 51′ 09″.44 read 40° 51′ 07′.44.

In Coast Survey Report for 1858.

Page 193: Line 10, for "a," read "a_1"

Page 193: Line 10 from bottom, for "a," read "$_1$"

Page 235: Line 13, strike out "$\frac{3000}{3487}$."

Page 359: Line 20, for 10″.3 read 20″.4.

Page 359: Line 21, for 29″ read 28″.8.

Page 381: Line 13 from bottom, for 45′.3 read 45″.3.

Page 429: Line 3, for 123° 14 read 123° 14′.

Page 442: Line 9, for 25″.6 read 25″.8.

REPORT.

SUPERINTENDENT'S OFFICE, CHESHIRE, CONN.,
October 28, 1858.

SIR : In compliance with the law of 1853, and the regulations of the Treasury Department, I have the honor to submit my annual report for 1858, showing the work done in the survey of the coast, between November 1, 1857, and the same date of the present year.

As usual the survey has been inp rogress in the field, afloat, or in the office-work, of all the maritime States and Territories of the United States in which it is not essentially completed. The scale of the work or rate of progress is determined by the amount of appropriations. The means for the work now reported upon were derived from eight months of the appropriations for 1857–'58, and four months of those of 1858–'59. The available means from different sources for this latter fiscal year were, as will be shown presently, ninety thousand dollars less than for the former.

Retaining, as convenient, the form given to my recent reports, the three divisions will be—the introduction, the description of operations, and the appendix.

I. The introduction gives a general account of the progress of the survey, with brief discussions of the leading features, the estimated progress for the next fiscal year, and the means necessary to secure it. The scale of progress and estimate is brought to that of the appropriations for the present fiscal year.

II. The operations are referred to in geographical order, beginning at the northeastern boundary on the Atlantic and proceeding southward, and along the coast of the Gulf of Mexico to the boundary ; then passing to the Pacific, at the southern boundary, and going northward. The coast is divided into Sections, and the work in each is described in one chapter, preceded by a short introduction, and giving the statistics, details of work done, remarks by the surveying officers, and the like. In this part of the report the name of each officer of the survey appears in connection with the work for which he is responsible, and to the credit of which he is entitled.

III. The Appendix contains matter useful to the navigator and commercial man, and to the surveyor, with lists and more detailed information on certain points than is given in the body of the report. It is subdivided as follows, for convenience of reference : 1. *Field, office, and hydrographic details*, given in general lists, showing the distribution of the Coast Survey parties; the names of army and navy officers, and the dates of their detail for and detachment from the work; information communicated from the archives; statistics of field and office-work; detached surveys made on the Western Coast; developments and discoveries in the regular progress of the hydrography; tidal data, and the reports of the different divisions of the office. 2. *Special operations and scientific discussions* relative to latitudes, longitudes, astronomical and geodetic methods, magnetism, tides, and currents; the mathematical and physical questions embraced in the scope of the survey. 3. *Local surveys,* including reports on the survey of special localities, their features, topographical and hydrographic, and their resources. 4. *Miscellaneous, scientific, and nautical matters,* including methods and instruments used in the survey, and memoirs relating to it, sailing directions, and the like. 5. *Light-house matters.*

A table of contents and an alphabetical index precede the report.

In section 4 of the Appendix of this year are given two especially interesting papers—one a Directory for the Western Coast of the United States, (No. 44,) and the other (No. 40) a notice of the progress and cost of foreign surveys.

The first part of the introduction refers to the progress of the survey and estimates; the last to remarks on the operations.

GEOGRAPHICAL SECTIONS—ESTIMATES OF PROGRESS AND COMPLETION.

Having gone very fully into the estimate of completion in my report of last year, I refer to it to avoid repetition now. The sections on the Atlantic and Gulf coast were in different stages from entire completion, viz: Section II; three-fourths of Section III; more than half of Sections I and IV; nearly half of Section V; between one-half and one-third of Section VIII; more than a third of Section IX; one-fourth of Section VI; between one-fifth and one-sixth of Section VII. The Atlantic coast was estimated as two-thirds done, and the Gulf coast as one-third. At the rate of appropriation it was estimated that the entire Atlantic and Gulf coasts might be essentially completed in from ten to twelve years. Where the conclusions were uncertain in regard to any particular section, as, for example, in reference to Sections VI and VII, the doubt was expressed. These estimates are reviewed from year to year, under the light of new results and new circumstances. The rate of progress now reported is nearly the same as then, one-third only of the fiscal year, with the diminished appropriation entering into the account, given in this report.

The geographical sections are as follows:

SECTION I. *From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*

SECTION II. *From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.*

SECTION III. *From Cape Henlopen to Cape Henry, including the coast of part of Delaware, Maryland, and part of Virginia.*

SECTION IV. *From Cape Henry to Cape Fear, including part of the coast of Virginia and North Carolina.*

SECTION V. *From Cape Fear to St. Mary's river, including part of the coast of North Carolina and the coast of South Carolina and Georgia.*

SECTION VI. *From St. Mary's river to St. Joseph's bay, including the eastern and part of the western coast of Florida, and the Florida reefs and keys.*

SECTION VII. *From St. Joseph's bay to Mobile bay, including part of the coast of Florida, and the coast of Alabama.*

SECTION VIII. *From Mobile bay to Vermilion bay, including the coast of Mississippi, and part of Louisiana.*

SECTION IX. *From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana, and the coast of Texas.*

SECTION X. *From San Diego to the forty-second parallel, including the coast of California.*

SECTION XI. *From the forty-second to the forty-ninth parallel, including the coast of Oregon and Washington Territories.*

GENERAL STATEMENT OF PROGRESS.

By a reference to Sketch map No. 40, the following condensed statement of progress will be rendered intelligible. The survey was last year reported as more than half done on the Atlantic and Gulf coast, and advancing at a rate which would insure its essential completion in from ten to twelve years. A steady persistence in the plan of operations marked out, and in the amount of means furnished, is all that is required to bring about this result. If the plan should be disorganized, or the means be necessarily reduced, all responsibility on my part for the results must, of course, cease. It is not an easy thing to accomplish, and requires all the aid and co-operation which the work has been so fortunate in finding in past years. An economy of some eighteen per cent. has resulted from the enlargement of the scale of operations, as shown between 1846 and 1855.

The triangulation of the Atlantic coast is continuous from within forty miles of the northeastern boundary of the United States to Shallotte inlet, ten miles above the southern boundary of North Carolina. A glance at Sketch No. 40, will show what a large portion of the Atlantic coast is embraced within these limits. With an interval on the coast of North and South Carolina of seventy miles, the triangulation extends unbroken to Sapelo entrance on the coast of Georgia. Three seasons more will probably connect the triangulations on the coast of Georgia, which were commenced at the various entrances, so as to furnish preliminary charts of them without delay. Two parties will work, filling up the interval between the St. Mary's and St. John's rivers, and that between Diego Plains and Cape Florida, one passing southward and the other northward. The triangulation of the Florida keys and reef is continuous along a line of a hundred and seventy miles from Cape Florida to the Marquesas, and two or three seasons more will connect the whole southern part of the main with the keys. The triangulation of Charlotte harbor has been commenced. The coast series on the western coast of Florida extends from Homosassa river to beyond Cedar Keys; over Ocilla river entrance and St. Mark's harbor; from Southwest Cape, east of Apalachicola, through St. George's Sound to Indian Pass; over St. Andrew's bay, and Pensacola harbor and approaches; from Mobile bay, which it covers, along the coast of Alabama, Mississippi, and Louisiana, to the lower part of Chandeleur Sound, and through lakes Borgne and Ponchartrain to New Orleans; over the mouths of the Mississippi, Isle Dernière, and Caillou bay, Atchafalaya and Côte Blanche bays. On the coast of Texas—over Galveston and East and West bays, and the coast to include Matagorda bay and entrance. A minute reconnaissance has been pushed forward to cover half of the remaining part of the coast; and the triangulation extends over the entrance of the Rio Grande.

Every harbor of importance in California and Oregon, and many in Washington Territory, have been surveyed; and the general coast triangulations, and those of Washington Sound, the Straits of Haro and Rosario, and of Puget's Sound and its dependencies are well advanced. These triangulations rest upon fifty-four base lines—ten principal and forty-four preliminary.

The topography of the immediate shores is based upon the triangulations, and the hydrography uses the shore lines and triangle points in its determinations.

The latitudes and longitudes of the principal headlands, capes, &c., are determined, and the direction (azimuth) of the principal triangle sides. The work is thus, as required by law, a geodetic work. The determinations of longitude by telegraph have greatly added to the accuracy of the survey. The older methods of determining the longitudes of points by astronomical observations and the transportation of chronometers have been carried out so as to comply with the law requiring the longitudes of important points in the survey to be determined from the well established European observatories. Preparations have been made from year to year for carrying forward the longitude points, to connect by telegraph with Europe at the earliest practicable period. Calais, in Maine, and New Orleans, in Louisiana, are now connected by a chain of telegraphic longitudes, including in its links Bangor, Me.; Cambridge, Mass.; New York; Philadelphia; Washington, D. C.; Petersburg, Va.; Raleigh and Wilmington, N. C.; Columbia, S. C.; Macon, Ga.; Montgomery and Mobile, Ala.

The "American method" of longitudes will bear favorable comparison, it is believed, with any other yet devised. It requires only the telegraphic connection with Europe to make its application to the first meridian of the survey complete.

The numerous triangulation stations are connected for longitudes with the coast points named, and Charleston and Savannah are connected with the series.

The hydrography has closely followed the triangulation and topography, preliminary triangulation being employed when waiting for the completion of the main work would have too long delayed the soundings.

The most dangerous parts of the coast, and those offering special facilities for navigation and commerce, have been the first to claim the attention of the survey. The method of separate bases and sections spread along the coast has permitted this. The closing of the work of one base upon another proves the work, and makes a connected system of the whole. The survey thus loses the rigidity which would confine it to continuous progress, and merely requires steadiness of execution, after the plan is once conceived, to bring it to a successful close.

The in-shore hydrography is nearly continuous from Cape Neddick, in Maine, to Ocracoke, in North Carolina, and the off-shore work embraces a very large area, including important localities, from the coast of New Hampshire to the upper limit of Florida, and in the Gulf of Mexico. The principal harbors on the Atlantic, south of the coast of Maine, including Portland harbor and other minor ones in that State, have been surveyed. There is a survey or hydrographic reconnaissance of more than three-fourths of the principal harbors on the Gulf of Mexico.

The report of last year gave a detail of the progress of the hydrography, and important additions in Maine, New Hampshire, Massachusetts, Maryland, North Carolina, South Carolina, Georgia, Florida, Louisiana, and California, have been made since. The coasts of New York, New Jersey, Delaware, Alabama, and Mississippi have been almost entirely completed.

The charts are regularly kept up with the work in the field and afloat. The amount of the appropriation determines the progress of the survey, and the operations are directed according to the plan submitted with the estimates of appropriation. The directions are submitted to the Secretary of the Treasury by the Superintendent, and, on receiving his approval, are carried out by instructions from the Superintendent to the assistants and others employed in the survey.

The work executed is delivered to the office, where the second computations are made, and the field maps reduced according to the scales suited to publication. The great effort has been to bring up the back work, and then to keep the computations, drawing, and engraving up with the field work. We are so near this point that there is a steady gain on the back work every year. The computing has overtaken it, and the drawing is not much behind. The engraving division has been considerably increased within two years in reference to this object, and is gaining. No important map or chart lies unused in the archives, but is immediately brought into requisition. To systematize the publications as early as a tolerably correct coast line could be had several series for maps and charts were planned, more particular reference to which will be made under a special head.

Charts of two hundred and eighty-six harbors, inlets, shoals, sounds, bays, features of the coast, etc., have been drawn, engraved, and published. The annual report of the survey contains, usually, about seventy charts and sketches showing the progress of the work, and diffusing important geographical and nautical information. Of the report of last year Congress ordered the publication of eleven thousand two hundred extra copies, namely : six thousand two hundred by the Senate and five thousand by the House of Representatives. Of these, eight thousand copies are to be distributed from the Coast Survey Office. The details of distribution, from approved lists, devolve upon the Assistant in charge of the office, who has been given the franking privilege, by legislation, in order to enable him to fulfil it.

My report of this year contains a most valuable contribution for the interests of commerce and navigation on our western coast in a Directory, containing notices of all the principal harbors, sailing directions for entering them, and for the coast generally, with lists of dangers, aids to navigation, and the like. Further reference to it will be made elsewhere in this introduction.

I have combined also with this, portions of a special report made last year to the Treasury Department, showing the progress of the work in different years and the comparison of its cost and duration with those of other surveys.

All experience has shown that one of the most expensive as well as tedious modes of effecting the survey of the coast of a country is to entrust it to a branch of government organized for some other purpose, and merely pursuing that work as an incident of its service, having no special interest in driving the work to completion, nor in economy of expenditures, because existing independently of the work and deriving existence and consequence and certain remuneration from other wants of the government. The Coast Survey organization is essentially a temporary one, and all its parts are planned with reference to executing a special work and then ceasing to exist. The work being once determined upon, and the rate of progress which the income of the government renders desirable being established, the time of completion becomes calculable. It is true existing maps afforded, originally, very imperfect data, and in many cases altogether deceptive ones; but then year by year this is remedied, as the data are more and more derived from the survey itself. During the progress of the survey the coast is divisible into two parts: that subject to change and that not so. The changing portions are comparatively small in extent. The land work being the most elaborate, and therefore the most expensive part of a geodetic survey, by preserving a sufficient number of stations for reference it becomes essentially a permanent result. If some of the stations are lost it is a matter of little import, as from those which remain the old ones may be replaced, or new ones may be established. Too much care cannot be taken to preserve enough points. When this is done thoroughly, all changes of the coast are easily mapped. The geodetic survey does not require renewal at all. Small triangulations take the place of large ones. The shore lines are easily traced. The hydrography is readily repeated. The expense of these partial surveys, after the main work is done, is insignificant. A comparatively small organization will secure that all the requirements of commerce and navigation are fulfilled. As an incident to this temporary organization is the possibility of promotion by merit, which is one of the cardinal features of the work, and to which it owes much of its progress.

PROGRESS DURING THE YEAR 1857-'58.

The general distribution of the parties along the coast and the progress of the work of each one are given in a tabular form in the Appendix No. 1, the table, with the progress sketch maps of the coast accompanying the report, and marked Nos. 1, 2, 7, 8, 10, 14, 16, 17, 19, 22, 24, 29, 30, and 33, showing in detail the limits of each operation. The progress to about November 1, 1858, has been as follows:

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.—(Sketches A and A bis, Nos.* 1 *and* 2.)—The primary triangulation has included Humpback Mountain, in Hancock county, Maine, and three stations only remain to complete it to the boundary of the United States. A reconnaissance has been made for continuing this work. Observations for latitude and azimuth and for the magnetic elements were made at the same station. The secondary triangulation of Penobscot bay has been commenced at the entrance. The secondary triangulation of the Kennebec has been carried eastward to Muscongus bay. The topography of the Kennebec and east to Wiscasset harbor and its approaches has been nearly completed. That of Casco bay has advanced eastward, and the details of the city of Portland have been mapped. That of the vicinity of Plymouth has been extended northward to fill up the vacancy on the western shore of Massachusetts bay. The hydrography of the Kennebec river to above Bath, Me., of the Sheepscot, and of Wiscasset harbor and its approaches, has been completed. That of Casco bay has been extended, connecting with the former work. That of the southern part of the coast of Maine, of the coast of New Hampshire, and the northern part of the coast of Massachusetts, has been in progress. A rock, the position of which was unknown, has been determined off the entrance to Portsmouth harbor, N. H. Revision work has been done in the harbors of Salem, Lynn, and Boston. Additional lines have been run towards George's bank, off the coast of Massachusetts. The tidal observations at Boston have been continued, and experiments with a new tide-gauge for deep-sea work have been made. The following maps and charts have been drawn this year: Rockport harbor and a sketch of the Epping Plains base, Me. The following have been in progress: finished maps from Portsmouth, N. H., to Cape Ann, Mass.; from Cape Ann to Scituate; from Scituate to Nausett, (Cape Cod;) the preliminary chart from Cape Neddick, Me., to Scituate, Mass.; and a general coast chart from Cape Ann, Mass., to Point Judith, R. I.

The engraving of the following has been completed: preliminary chart from Plymouth, Mass., to Saughkonnet river, R. I., and harbor charts of Annis Squam and Ipswich, Wood's Hole, and Bass river, Mass. Progress has been made on the preliminary chart from Portland, Me., to Race Point, Mass.; on the finished maps from Monomoy to Muskeget, Mass.; and from Muskeget to New Bedford, Mass. The preliminary chart of Kennebec river and sketch of Epping base, for the annual report, were engraved on stone under the direction of the Superintendent of the Public Printing.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware. (Sketch B, No. 7.)*—The difference of longitude between the station point near the Dudley observatory, at Albany, and the station point at Mr. Rutherford's observatory, New York City, has been determined by telegraph, closing in thus the triangulation of the Hudson. The magnetic elements were observed at the first named point, and observations were made for latitude at the last.

The triangulation of the Hudson river has been extended from above Rondout northward to the city of Hudson. The topography of the shores of the Hudson near New York and of the harbor of New York has been continued from the limits of last season. Some hydrography of revision has been executed in the Hudson. Tidal observations have been continued at New York. The levelings for the plane of reference of the Hudson have been repeated. Additional observations of tides and currents have been made east of Hell Gate and in New York harbor, the latter with especial reference to the currents below the surface.

Diagrams and sketches, showing the current stations and results of the observations of tides and currents in New York harbor entrance and in Sandy Hook bay, have been drawn and engraved, and the finished map of New York harbor has been in progress. A preliminary form has been given to this map for the report, and it has been engraved on stone under the direction of the Superintendent of the Public Printing.

SECTION III. *Coast of Delaware, Maryland, and part of Virginia.—(Sketch C, No. 8.)*—The triangulation of the Patuxent river, Md., has been completed to near Nottingham. That of the Potomac has been carried from the entrance to Piney Point, connecting it with the triangulation of the Chesapeake, and has been extended also below the primary lines near Washington, D. C. The topography of Chincoteague island, in the vicinity and south of the boundary line between Maryland and Virginia, has been completed. That of the city of Richmond and of the shores of York river, Va., has been completed. The hydrography has been finished in Fishing bay, Nanticoke and Wicomico rivers, and in Monic bay, at the head of Tangier sound. The tidal observations at Old Point Comfort have been continued.

The following drawings have been made: Chesapeake bay, from the Magothy to Hudson river, Maryland, and York river, Virginia, from the entrance to King's creek. The following are in progress: Chesapeake bay, in four sheets, from Hudson river, Maryland, to the Capes; Rappahannock river, two sheets, from Occupacia creek to the mouth; York river from King's creek to West Point; James river from Richmond to City Point.

The engraving of three sheets of Chesapeake bay from the head to the Potomac river has been in progress, and the maps will be issued in a preliminary form. The engraving of the map of the Patapsco has been continued. Preliminary charts of Hampton Roads and Elizabeth river, and of Norfolk harbor, have been engraved upon stone, under the direction of the Superintendent of the Public Printing.

SECTION IV. *Part of the coast of Virginia and North Carolina.—(Sketch D, No. 10.)*—The combined triangulation and topography of the coast of Virginia, between the head of Currituck sound and Cape Henry, have been continued. Sites for bases for testing the small triangulation of the coast of North Carolina have been selected between Cape Hatteras and Cape Fear. The topography of the coast between the same capes has been completed by the work from Stump inlet to New inlet, North Carolina. The shore lines of the Cape Fear entrances have been resurveyed for the United States Commission. The hydrography of the eastern part of Pamplico sound, abreast of Hatteras and south of Ocracoke; the in-shore work from Beaufort entrance to below Bogue inlet, and off-shore work near the same locality, have been executed; and observations have been made in the Gulf Stream in the same vicinity. Comparative maps of the Cape Fear surveys of 1853 and 1858, and sketches of Hatteras and Ocracoke inlets have been drawn. The general coast chart, No. V., from Currituck to Cape Fear, has been commenced; and preliminary charts, Nos. 11 and 12, from Hatteras to Cape Fear have been in progress. The charts of Beaufort harbor, North Carolina, and the Cape Fear entrances, have been engraved. Coast chart, No. 41, of the eastern part of Albemarle sound, and preliminary chart, No. 11, from Hatteras to Bogue inlet, have been in progress. The comparative charts of the Cape Fear entrances have been engraved upon stone, under the direction of the Superintendent of the Public Printing.

SECTION V. *Coast of North Carolina, South Carolina, and Georgia.—(Sketch E, No. 14.)*—The triangulation of the coast of North Carolina has been completed from Lockwood's Folly to Shallotte inlet, and the topography in conjunction with it to Tubb's inlet, North Carolina. The triangulation connecting Winyah bay, South Carolina, and Charleston, and from St. Helena sound to Savannah river, connecting the Winyah and Savannah preliminary bases and the main Edisto base by secondary work, has been completed; and that of Ossabaw and St. Catharine's sounds, Georgia. The secondary triangulation of this section gives a connected chain from Winyah bay to Sapelo sound. The topography of the Cape Fear entrances has been reviewed for the United States Commission; that of Winyah bay has been verified; that of the changing parts of Charleston harbor, and the approaches, repeated; that of the shores of St. Helena sound, continued; that of Ossabaw sound, and the Ogeechee and Vernon rivers, and the shores of the inland passage from Savannah river to Ossabaw, and of Sapelo sound and river to Sutherland's bluff has been completed. The topography of Brunswick harbor, Turtle river, and Jekyl island is essentially complete. The hydrography of the Cape Fear entrances has been re-examined for changes, by request of the United States Commissioners. Maffitt's channel, Charleston harbor, has been resurveyed. Off-shore work from Cape Roman to Fernandina has been executed; and the soundings of Sapelo sound and river to Sutherland's bluff completed. Tidal observations have been made at Charleston, and near St. Mary's, Georgia.

The drawing of the chart of St. Helena sound has been completed. Charts of St. Mary's bar and Fernandina harbor; of St. Simon's sound and Brunswick harbor; additions to Charleston harbor, and of Bull's bay, have been drawn; and coast chart, No. 52, from Rattlesnake shoal to St. Helena sound, has been in progress.

The engraving of preliminary chart, No. 14, Cape Roman to Tybee; of the chart of St. Simon's and Brunswick, and of St. Mary's and Fernandina harbor, have been completed. Preliminary charts of Bull's bay and Roman inlet, and of St. Helena sound, have been engraved upon stone, under the direction of the Superintendent of the Public Printing.

SECTION VI. *Coast, reefs and keys of Florida.—(Sketches F, Nos.* 16 *and* 17.)—The triangulation of the line across the head of the peninsula, from Fernandina to Cedar keys, has been in progress, the lines having been opened to Trail ridge; that of the eastern coast has advanced from the St. John's to Diego Plains; that connecting the Cape Sable base with the triangulation of the keys, and thus with Key Biscayne base is completed; that of Charlotte harbor has been carried from a preliminary base on Sanibel island, over San Carlos bay northward to Boca Grande and Captiva Pass. The topography of the eastern coast of Florida has been carried from the St. John's to Diego Plains; that of the keys between Key Largo and Long key, including Upper and Lower Matecumbe, and several smaller keys, has been completed, and the quarter sections marked for the General Land Office; and progress has been made in the topography of the entrance to Charlotte harbor. The soundings off the Florida keys and reef have been extended from Bahia Honda, eastward and northward, to Key Vacas. A section of the Gulf Stream has been made from the Tortugas to Havana, and another from Havana to Key West, giving the depths and temperatures.

A comparative chart of St. John's bar, from the surveys of 1853 and 1857, has been drawn, and the following have been in progress: two sheets of the preliminary charts of the Florida reefs and keys, from Virginia key, southward; three sheets of the finished chart from Virginia key to Newfound harbor, and one of Key West and its approaches. The chart of Legaré anchorage has been engraved, and progress made in the preliminary chart No. 19, from Cape Florida to Key West.

SECTION VII. *Part of the western coast of Florida.—(Sketch G, No.* 19.)—The triangulation has been carried southward to Homosassa point; that of St. George's sound has been completed to Southwest Cape; that of the Lagoon has been carried westward from Pensacola entrance; and that of Escambia bay, from its entrance to Live Oak point. Astronomical and magnetic observations have been made at Pensacola. The topography of the section has followed closely upon each of these triangulations. The hydrography has included the east and west passes into Apalachicola, and the discovery and development of a new channel near the eastern end of Dog island. A map of Pensacola harbor has been drawn and engraved for issue as a preliminary chart; and a preliminary chart of Apalachicola harbor has been engraved on stone, under the direction of the Superintendent of the Public Printing.

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana.—(Sketch H, No.* 22.)—Difference of longitude has been determined by telegraph between Mobile and New Orleans for the connection of Washington and New Orleans, and the magnetic elements have been observed at the last named city. The triangulation at the Belize has been approximately connected for longitudes by telegraph with the New Orleans station. The connection of New Orleans with the Pontchartrain triangulation has been completed, and some supplementary work done in Lake Pontchartrain. A preliminary base has been measured for the triangulation of the Mississippi delta, and the triangulation carried over the Passes. Observations for latitude and azimuth have been made in connection with the work at the delta. The triangulation has been extended in Côte Blanche bay, Louisiana, and reconnaissance made for carrying it over Vermilion bay. The topography of the neck between Lakes Borgne and Pontchartrain has been executed in the vicinity of Lake St. Catharine. The hydrography of Atchafalaya bay, east of the meridian of Point au Chevreuil, has been executed, and a reconnaissance made in the southwest part of Lake Borgne. A line of soundings has been run from the Atchafalaya entrance to the mouths of the Mississippi, and thence to the Tortugas, with temperature observations.

The following drawings have been in progress: preliminary charts, Nos. 25 and 26, of Mississippi sound, from Mobile bay to Lake Pontchartrain; seacoast chart, No. 92, Round island to Grand island, Mississippi sound; and No. 93, Grand island to Lake Pontchartrain, have been commenced. Progress has been made in the engraving of the charts just enumerated, and on the plate of Biloxi bay. Preliminary charts of Mississippi harbor; St. Louis bay and Shieldsboro' harbor, and of Grand Island pass have been engraved on stone for the report of 1857, under the direction of the Superintendent of the Public Printing.

SECTION IX. *Coast of part of Louisiana and coast of Texas.—(Sketch I, No.* 24.)—A plane table reconnaissance and selection of stations for triangulation has been carried to Aransas pass, and sketches of the tract between it and Matagorda have been drawn. The topography of Lavacca bay has been completed. A reconnaissance of the Brazos bar has been made, and of the river to Velasco. Lines of soundings have been run from the Mississippi delta to Galveston entrance.

A chart of Matagorda entrance has been drawn, and two seacoast maps (Nos. 105 and 106) of the coast of Texas have been in progress.

The engraving of preliminary chart No. 31, Galveston to Matagorda bay, has been completed, and the preliminary chart of Matagorda entrance has been engraved on stone, under the direction of the Superintendent of the Public Printing.

SECTION X. *Coast of California.—(Sketches J and J bis, Nos.* 29 *and* 30.)—The triangulation of the Santa Barbara channel has been carried westward to San Buenaventura. Preliminary bases have been measured on San Nicolas and San Miguel islands, and the triangulation of the islands made. The topography of this quarter has followed closely the triangulation. The triangulation of Tomales bay has been completed; that of Petaluma and Napa creeks has been made, and a station of the primary work on Tomales bay has been occupied. The topography of the dependencies of San Francisco bay has been brought nearly to a close. A plane-table survey of Point Duma has been made for light-house purposes. The reports of field-work from this section are not complete at the present time. Additional hydrography in the approaches to San Francisco bay has been executed. A reef in San Francisco bay, on the Contra Costa flats, was determined in position, and Whiting's rock, in the vicinity of the Brothers, near the entrance of San Pablo bay. The positions of the buoys in San Francisco bay were determined, at the request of the light-house inspector. Tidal observations have been kept up at San Diego and San Francisco, and meteorological observations in connection with them.

Drawings have been completed of the chart of Monterey bay; additions to that of San Francisco entrance; and the chart of Humboldt bay. The finished map of San Francisco bay and vicinity has been in progress. The engraving of the chart of San Diego bay; of the eastern entrance to Santa Barbara channel; of San Antonio creek; and of Monterey bay, as a preliminary chart, has been completed.

SECTION XI. *Coast of Oregon and Washington Territories.*—(*Sketch K, No.* 33.)—The reports of the combined triangulation and topographical party in this section have not yet been received. Their instructions direct them to give aid in reference to the boundary surveys.

Additions have been made to the sketch of Canal de Haro and Straits of Rosario, Washington sound, and a sketch of Semiahmoo bay has been drawn.

The following list contains the titles of maps, preliminary charts, and sketches accompanying this report, arranged in geographical order. The letters of reference in the margin apply to the different sections; A to Section I, B to Section II, and so on. The numbers on the maps and sketches themselves correspond with those of the list. Miscellaneous diagrams are placed towards the end.

1.—A. Progress sketch, Section I, (primary triangulation.)
2.—A *bis.* Progress sketch, Section I, (secondary triangulation, topography, and hydrography.)
3.— Kennebec river from the entrance to Bath, Me.
4.— Seacoast of Maine, New Hampshire, and Massachusetts, from Bald Head, Me., to Cape Cod, (preliminary chart No. 3.)
5.— General coast chart No. II, from Cape Ann to Gay Head, Mass.
6.— Rockport harbor, Mass.
7.—B. Progress sketch, Section II.
8.—C. Progress sketch, Section III.
9.— York river, Va., from King's creek to West Point.
10.—D. Progress sketch, Section IV.
11.— Seacoast of North Carolina from Cape Hatteras to Cape Lookout, (preliminary chart No. 10.)
12.— New Inlet, N. C., (entrance to Cape Fear river,) comparative map.
13.— Cape Fear River entrance, N. C., (comparative map.)
14.—E. Progress sketch, Section V.
15.— Charleston harbor, S. C., (new edition.)
16.—F No. 1. Progress sketch, Section VI, (Florida peninsula.)
17.—F No. 2. Progress sketch, Section VI, (Florida reefs and keys.)
18.— Florida reefs and keys from Virginia Key to Carysfort reef.
19.—G. Progress sketch, Section VII.
20.— St. George's sound, Fla., (East Pass.)
21.— Apalachicola bay, Fla.
22.—H. Progress sketch, Section VIII.
23.— Atchafalaya bay, La.
24.—I. Progress sketch, Section IX.
25.— Coast of Texas from Galveston bay to San Luis Pass.
26.— Coast of Texas from San Luis Pass to the head of Matagorda bay.
27.— Brazos river entrance and channel to Velasco, Tex., (reconnaissance.)
28.— Espiritu Santo, San Antonio, and Aransas bays, and adjacent coast of Texas, (general reconnaissance.)

29.—J No. 1. Progress sketch, Section X, (San Diego to San Luis Obispo, Cal.)
30.—J No. 2. Progress sketch, Section X, (San Luis Obispo northward to Bodega bay, Cal.)
31.— San Francisco city, Cal.
32.— Humboldt bay, Cal.
33.—K. Progress sketch, Section XI.
34.— Canal de Haro and Strait of Rosario, W. T.
35.— Port Gamble, W. T.
36.— Port Townshend, W. T.
37.— Semiahmoo bay, W. T.
38.— Diagrams illustrating the descent of the weight and line in deep-sea soundings.
39.— Current stations occupied near Sandy Hook, and diagrams showing velocities, &c.
40.— Project limits for finished charts of the Atlantic and Gulf coasts of the United States, scale $\frac{1}{80000}$.

ESTIMATES.

The estimates which follow show the particulars of the work proposed for the different parts of the coast for the fiscal year 1859–'60. The sum total is the same as that appropriated in 1858–'59, and less than that of the years immediately preceding.

The estimates suppose the same aid from the War and Navy Departments as heretofore. Should any part of this be withheld, the proportionate progress of the survey must be diminished.

The table which follows the detailed estimates gives in parallel columns the estimates for the next fiscal year, and the appropriations of the present year, 1858–'59. These appropriations were less by $30,000 than for the previous year, 1857–'58, besides which no appropriations were asked by the Interior Department for the survey and marking of the Florida Keys and of the islands off the Western Coast, making a diminution of $90,000 in the available means for the progress of the survey in 1858–'59.

The item for pay of engineers had previously been included in the naval estimates, but the exigencies of the service induced the withdrawal of the naval engineers attached to the Coast Survey steamers.

Estimates in detail for the fiscal year 1859–'60.

For general expenses of all the sections, namely: rent; fuel; materials for drawing, engraving, and printing, and ruling forms; binding; transportation of instruments, maps, and charts, and for miscellaneous office expenses; and for the purchase of new instruments, books, maps, and charts.......................... $19,000

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To continue the primary triangulation in Maine, east of *Humpback Mountain,* and to make the necessary observations for longitude, latitude, and azimuth, and magnetic observations, and to connect the base on *Epping plains, Me.*, with the triangulation; to extend the secondary triangulation of the *Penobscot* northward, and that of *Booth bay, Me.*, eastward; to continue the topography of the middle portion of *Casco bay,* that of coast east of the Kennebec, and of *Cape Cod* *bay* below *Manomet;* to continue the hydrography of *Casco bay,* extend that of the coast east of the *Kennebec,* and continue that off the *coast of Maine* and *New Hampshire;* to complete the deep-sea work off the *coast of Massachusetts,* between it and *George's bank,* and beyond *George's;* to continue the observations of tides and currents in the section, completing those of *Nantucket sound* and of the coast of *Cape Cod;* and to take the views required for charts. OFFICE-WORK.—To continue the requisite computations; to commence the drawing of a chart of *Wiscasset harbor;* to complete the drawing of the *Kennebec river,* from the entrance, to *Bath;* to make a preliminary chart of *Jebeig Island* channel, *Casco bay;* to continue the drawing of preliminary chart No. 3, from *Portland* to *Cape Cod,* and of off-shore chart No. II, from *Cape Ann* to *Point Judith,* and the sketches of the section, including diagrams of the observations of tides and currents; to commence the engraving of the general coast chart of Maine, No. 1 $\frac{1}{400000}$; of the finished chart of *Cape Cod bay,* (No. 10;) to continue that of *Portland harbor;* of eastern series No. 3, (*Nantucket,*) or coast charts Nos. 10 and 12; to complete that of *Kennebec river, Rockport harbor,* and eastern series No. 2, (*Martha's Vineyard,*) or coast chart No. 13; and the sketches of the section, including diagrams of the tides and currents in *Nantucket sound,* and of the approaches, will require $41,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.* FIELD-WORK.—To continue the triangulation, topography, and hydrography of *Hudson river,* and the topography and hydrography of *New York bay;* to execute work of verification in the section, and to continue the observations of tides and currents. OFFICE-WORK.—To make the requisite reductions and computations; to complete the drawing of the finished map of *New York harbor and bay;* to continue that of the lower sheet of the *Hudson,* and to draw the diagrams and sketches required by the tidal and current results; to continue the engraving of the chart of *New York bay and harbor, Hudson river,* and the tidal and current diagrams and sketches of the section, will require.................................. 8,000

SECTION III. *Coast of Delaware, Maryland, and Virginia.* FIELD-WORK.—To continue the astronomical and magnetic observations required in the section; to continue the triangulation of *Potomac river;* to commence the topography of the upper *Patuxent,* and continue that of the *James river* and *Potomac,* and of the outer coast of *Maryland;* to complete that of the shores of *Chesapeake bay;* to continue the off-shore hydrography of the section and work of verification in the *Chesapeake,* and its tributaries; to continue the hydrography of the *Potomac,* and the tidal observations of the section. OFFICE-WORK.—To make the computations required by the field-work; to complete the drawing of the chart of *York river, Va.,* from *King's Creek* to *West Point;* to make drawings of the *Patuxent river* and *St. Mary's river, Md.;* to commence the off-shore chart No. IV, from *Cape May to Currituck sound;* coast chart No. 28, from *Cape Henlopen* to *Green Run inlet;* and coast chart No. 29, from *Green Run inlet* to *Wachapreague inlet;* to continue the engraving of the *Chesapeake bay* series Nos. 2, 3, 4, 5, and 6, (coast charts Nos. 32 to 36,) and complete those of *Patuxent river, St. Mary's river,* and

York river, (upper sheet,) and *Chesapeake bay* No. 1, (No. 31,) and to engrave the preliminary sketches of the section, will require $25,000

SECTION IV. *Coast of Virginia and North Carolina.* FIELD-WORK.—To make astronomical and magnetic observations at *Cape Fear entrance;* to continue the triangulation of *Pamplico sound*, and to measure bases of verification; to complete the topography north of *Currituck sound;* to continue the outer hydrography south of the boundary line of *Virginia* and *North Carolina*, south of *Ocracoke*, and south of *Bogue inlet, N. C.;* to continue observations of the tides and currents and of the *Gulf Stream.* OFFICE-WORK.—To make the computations and reductions; to continue the drawings of preliminary charts No. 11, from *Cape Hatteras to Cape Lookout*, and No. 12, from *Cape Lookout* to *Cape Fear;* to commence coast charts No. 46, from *Cape Lookout* to *New River inlet;* No. 47, from *New River inlet* to *Barren inlet;* and No. 48, from *Barren inlet* to *Lockwood's Folly inlet;* to commence the engraving of *Albemarle sound*, Nos. 1 and 2, (coast charts Nos. 40 and 41;) the preliminary chart No. 12, *Cape Lookout* to *Cape Fear*, and the preliminary sketches of the section, will require 26,000

SECTION V. *Coast of North Carolina, South Carolina, and Georgia.* FIELD-WORK.—To extend the triangulation in *North* and *South Carolina*, and topography connected with it, from *Tubb's Inlet*, southward; the primary triangulation of the coast of *South Carolina*, north and south of *St. Helena sound*, and the secondary triangulation up the rivers; to measure supplementary bases on the coast of *South Carolina* or *Georgia;* to complete the triangulation between *St. Simon's* and *Sapelo sounds;* to complete the triangulation of *Doboy* and *Altamaha sounds*, and approaches, and that of the *Altamaha river;* to continue the topography connected with these triangulations; to continue the hydrography of *Broad river* and its tributaries, and to complete the off-shore hydrography of the *coast of South Carolina and Georgia;* to complete the hydrography of *Wassaw, St. Catherine's*, and *Sapelo sounds*, and their connections, and of *Doboy* and *Altamaha sounds;* to continue tidal observations and investigations of the *Gulf Stream* in this and the preceding sections. OFFICE-WORK.—To make the computations and reductions which may be necessary; to continue the drawing of coast chart No. 53, from *Charleston* southward, and including *St. Helena sound;* to make drawings of *Sapelo sound* and of *Wassaw* and *Ossabaw sounds*, the *Vernon, Great and Little Ogechee; Sapelo river* and other dependencies; to complete the engraving of charts of *Wassaw* and *Ossabaw* and *Sapelo sounds;* and to engrave the preliminary sketches of the section, will require 36,000

SECTION VI. *Keys, Reefs, and Coast of Florida.* (See estimates of appropriation for those special objects.)

SECTION VII. *Western Coast of Florida.* FIELD-WORK.—To continue the triangulation and topography southward from *Homosassa Point*, and north from *Cedar keys;* the triangulation from *Southwest Cape* eastward to *St. Mark's* and *Ocilla river*, and the topography in conjunction with it; to continue the triangulation and topography in *East* and *Escambia bays*, near *Pensacola;* to make the necessary astronomical and magnetic observations in the section; to continue the hydrography in connection with the triangulation and topography and the deep-sea soundings on the *Gulf coast;* to make tidal observations at *Cedar keys* and *Pensacola.* OFFICE-WORK.—To draw the charts of *St. George's sound* and *Apalachicola river* entrance, and to commence those of *East* and *Escambia bays;* to make the reductions and computations required; to complete the engraving of *St. George's sound* and *Apalachicola river;* that of *Pensacola harbor,* and to engrave the preliminary sketches, will require $36,000

SECTION VIII. *Coast of Alabama, Mississippi, and Louisiana.* FIELD-WORK.—To continue the triangulation of *Isle au Breton sound* and *islands;* to continue that of the *Mississippi delta,* and to extend it northward and westward; to extend the triangulation from *Côte Blanche bay* northward and westward into *Vermilion bay,* and southward over *Marsh island;* to continue the topography connected with these several triangulations; to continue determinations for longitude, and the astronomical and magnetic observations necessary in the section; to continue the hydrography of *Chandeleur sound* and approaches and of the *Mississippi Passes;* to complete that of *Atchafalaya bay* and approaches; and to continue the deep-sea soundings off this section of the *Gulf coast.* OFFICE-WORK.—To make the reductions and computations; to continue the drawings of the finished map of *Mississippi sound, from Grand island to Lake Pontchartrain;* to continue the map of *Chandeleur sound,* and to make a drawing of *Atchafalaya bay;* to continue the engraving of *Mississippi sound,* Nos. 1 and 2, and to complete the engraving of *Atchafalaya bay* and the preliminary sketches of the section, will require 33,000

SECTION IX. *Coast of part of Louisiana and Coast of Texas.* FIELD-WORK.—To complete the minute reconnaissance of the coast, and to extend the main and secondary triangulations from *Cavallo Pass* southward, to include *San Antonio bay;* to continue the topography of the coast south of *Cavallo Pass,* and of the shore of *San Antonio bay;* to complete the in and off-shore hydrography near *Matagorda bay,* and between it and *Galveston entrance;* to make the tidal observations which may be requisite. OFFICE-WORK.—To make the necessary computations; to continue the drawing of the coast chart of the vicinity of and including *Matagorda bay;* to complete coast chart No. 106 from *Galveston to San Louis Pass,* and No. 107 from *San Louis Pass to Matagorda;* to make a chart of *Brazos entrance* and *river,* and the sketches of the section; to continue the engraving of seacoast chart No. 32; to complete that of the *entrance* to *Brazos river;* to commence the engraving of coast chart Nos. 106 and 107; and to engrave the preliminary sketches of the section, will require 26,000

Total for the Atlantic coast and Gulf of Mexico, excluding estimates for the Florida reefs and keys, and for the Western Coast 250,000

The estimates for the Florida reefs, keys and coast, and for the Western Coast of the United States, are intended to provide for the following progress:

SECTION VI. *Reefs, keys, and coast of Florida.* FIELD-WORK.—To continue the triangulation of the eastern or *Atlantic coast* of the peninsula south of *St. Augustine*, and, if practicable, south of *Cape Cañaveral;* to continue the triangulation of the keys, between the outer keys and main *Coast of Florida;* to connect, if practicable, the *Marquesas* and *Tortugas;* to make the requisite astronomical and magnetic observations in connection with the triangulation of the reefs and keys; to extend the triangulation on the western coast of the peninsula northward, over *Charlotte harbor;* to continue the topography of the inner keys of *Florida bay* and *Barnes' sound*, and of the main coast, and that of *Charlotte harbor;* to commence the hydrography of *Florida bay* and *Barnes' sound*, and to continue that of the *Florida reef*, completing the inner and reef work; to continue the tidal observations at *Tortugas*, *Charlotte harbor* and *Tampa bay.* OFFICE-WORK.—To make the requisite computations from the field-work; to complete the drawing of the seacoast chart, No. 7, from *Newfound harbor key to Key West*, and continue that of preliminary charts, Nos. 19 and 20, from *Virginia key to Tortugas;* to commence the engraving of coast charts Nos. 68, 71 and 72, from *Key Biscayne to Key West*, and to engrave the preliminary sketches of the section, will require $40,000

SECTION X. *Coast of California.* FIELD WORK.—To continue the main triangulation of the coast from *Tomales Station* northward, and to execute the secondary and tertiary work north of *Tomales* and *Drake's bays* and south of *Monterey;* to continue the main triangulation of the *Santa Barbara channel*, and the connection of its islands with the main; to complete the topography of the same region; to continue that of the *Coast of California*, south of *San Francisco entrance* and south of *Monterey;* to complete the off-shore soundings near *San Francisco* entrance, and north and south of it; to continue the regular hydrography of the coast north and south of *San Francisco;* to continue the tidal observations; to make the requisite magnetic observations; and to prepare views for the charts. OFFICE-WORK.—To make computations as required by the field-work; to complete the finished map of *Monterey bay*, and that of *San Francisco* and *San Pablo bays*, and to draw the plan of *San Francisco city;* to continue the engraving of *San Francisco* and *San Pablo bays*, $\frac{1}{50000}$; to continue that of *Monterey bay;* to complete the engraving of the plan of *San Francisco city;* and to engrave the preliminary sketches of the section. Also, for the operations in

SECTION XI. *Coast of Oregon and Washington Territories.* FIELD-WORK.—To continue the triangulation of *Washington Sound*, or of *Puget's Sound*, and *Hood's Canal*, from the limits of 1858, and the topography and hydrography of their dependencies; to make such astronomical and magnetic observations as may be necessary; and to continue tidal observations in the section. OFFICE-WORK.—To make the required computations and reductions from field-work; to draw a finished map of *Port Townshend;* to continue the drawings of *Washington Sound*

and Puget's Sound; to complete the engraving of *Port Gamble* and *Port Townshend,* and to engrave the preliminary sketches of the section, will require	$130,000
For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, per act of March 3, 1843 ...	5,000
For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843	5,000
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	10,000
For pay and rations of engineers for seven steamers, used in the hydrography of the Coast Survey, no longer supplied by the Navy Department	12,800

The amounts thus estimated for the work of the fiscal year 1859–'60, and the corresponding appropriations for the present fiscal year, are given below in parallel columns:

Object.	Fiscal year 1859–'60.	Fiscal year 1858–'59.
	Estimated.	*Appropriated.*
For survey of the Atlantic and Gulf coast of the United States, (including compensation to Superintendent and assistants, and excluding pay and emoluments of officers of the army and navy and petty officers and men of the navy employed on the work,) per act of March 3, 1843	$250,000 00	$250,000 00
For continuing the survey of the Western Coast of the United States, per act of September 30, 1850	130,000 00	130,000 00
For continuing the survey of the Florida reefs and keys, (excluding pay and emoluments of officers of the army and navy and petty officers and men of the navy employed on the work,) per act of March 3, 1849	40,000 00	40,000 00
For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, per act of March 3, 1843	5,000 00	10,000 00
For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843	*5,000 00	
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	10,000 00	10,000 00
For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department	†12,800 00	12,800 00

* $15,000 was the appropriation for 1857–'58. † Included formerly in estimates of the Navy Department.

In the autumn of 1857 the Treasury Department called for a special report showing "the moneys expended yearly by the Coast Survey and the work executed in each year, and also the weights and measures furnished the different States and custom-houses, and the cost of the same," from the commencement of these works, respectively. Materials for this report were at once collected, and it was written as soon as the annual report was finished and presented to the Secretary of the Treasury, in December, 1857. A list of the papers which accompanied it will be found in Appendix No. 42.

The results arrived at from the discussion of the several questions which presented themselves in the course of this report were summed up in eighteen propositions; the proofs of which were given as briefly as possible in the body of the report, and the full discussion of which, with the data upon which it was founded, was given in the papers of the Appendix to the report.

I propose now to review this discussion in the present report, by presenting the several propositions in their order, and by abridging the remarks made in demonstration of them.

1. The survey has been extended into every seaboard State and Territory of the United States.

It is now in progress, either in field or office work, in all the States on the Atlantic and Gulf of Mexico, and in California and the Territories of the Pacific.

Texas was annexed in 1845, California was added to our Union in 1849, and the survey was at once commenced in both; and within two years and a half a reconnaissance of California and Oregon and Washington Territories was made and published.

The coast being divided into sections, the survey can go on as rapidly as is deemed desirable. Section II was nearly completed in 1844; Sections I and III were in progress in 1844; Sections IV and VIII were commenced in 1845; Sections V and IX in 1847; Sections VI and X in 1849; Section XI in 1851, and Section VII in 1852, each section being put under survey as rapidly as the extension of the appropriation would permit.

2. Taking all the operations into consideration, the Atlantic sections are more than half done, the Gulf sections are nearly one-third done, and both can, at the present rate of appropriation, be completed in from ten to twelve years by close economy and thorough efficiency of arrangement. Nothing less will do it.

This proposition is proved by a review of the past progress and an estimate of the future in the several sections from Passamaquoddy to the Rio Grande.

The discussion is given in brief in my report of last year, and further examination has not altered the conclusion then arrived at.

It should be recollected that the rate of appropriation was specially referred to, and was that of 1857–'58, exceeding by $90,000 that of 1858–'59.

3. The extension of the Coast Survey has been made the subject of repeated report, and has met the favorable action of the several Executives and of different Congresses for the last fourteen years.

The advantages of a speedy completion of the work, the economy of an enlarged scale, and the prosperity of the country, have combined to make this extension desirable in the judgment of the Executive and legislative authorities of the country.

In regard to it the Secretary of the Treasury thus spoke in his report to the Senate in 1851:

"At the close of 1844 it became obvious to the Superintendent of the Survey that thirty years of progress, at the rate of appropriation and plan of operating, would not take the survey to the mouths of the Mississippi. He stated frankly, in his report, the necessity for greater expedition, and the plan by which it could be obtained—the division of the coast into sections, and the commencement of the survey in as many as Congress would provide appropriations for."

"At this time Texas was not annexed, and the Western Coast was not in possession of the United States."

"This plan has received the sanction of Congress in successive years from 1844 up to the present, when every appropriation asked for, except that of the Florida reef, which is the same as last year, is less than was appropriated about three months ago for the same service for the present fiscal year."

"Nor is this increase like that of an appropriation for a branch of service which must always have an existence, since it decreases the time during which the survey will last."

Again: "While the appropriations asked for the Coast Survey were increased two-fold, the amount of work executed was more than three-fold. This economy results from the division of labor which an increased scale permits, and from the vigorous pushing of the work at the south as well as at the north, by which the best season for surveying is used by the same persons in each region."

4. Compared with those of other nations, the surveys undertaken by the United States have been on a moderate scale of expenditure.

The trigonometrical survey of England alone had cost up to 1856 five millions of dollars; that of Ireland, five millions three hundred thousand dollars; that of Scotland, one million four hundred thousand dollars; making, for the United Kingdom, eleven and a half millions of dollars. This is for the land work. Besides this, over ten millions of dollars were expended in hydrography. The total cost of the field and office work of the United States Coast Survey from 1843 to the middle of the year 1857, including the estimated facilities furnished by the Navy Department, and deducting the estimated value of public property then on hand, (omitting the original maps and charts,) was less than four and a quarter millions of dollars.

The new map of France has already cost more than one million of dollars, and since 1834 France has expended four millions three hundred thousand dollars in hydrography.

An interesting recapitulation of his notes of foreign surveys is given by Professor Trowbridge. Appendix No. 40.

5. In comparison with foreign surveys, (and nearly every civilized nation has deemed it essential to survey not only its coast but the interior of its territory,) it will be seen that the progress of the United States Coast Survey has been satisfactory as regards time.

(1.) The great trigonometrical and hydrographic surveys of Europe and India have been in progress since the beginning of the present century. The survey of *Great Britain*, which is not yet completed, was commenced in 1791. The surveys of *France* have been in progress nearly one hundred years. The work upon the new map was commenced in 1816, and is now about two-thirds completed. The survey of *Russia* has been in operation thirty years, and one-fourth of the empire is now completed. The surveys of *Germany* generally, including *Prussia* and *Austria*, were commenced at the beginning of the present century. The survey of India has been in hand nearly sixty years.

(2.) As far as the United States has undertaken a similar work, in the survey of its coast, the progress made has been entirely satisfactory, more than half of the Atlantic and Gulf coast of the United States having been completed in less than twenty-five years, and giving fair promise of the completion of the field work in twelve years more.

6. Compared with the cost of foreign surveys, per square mile or acre, or per lineal foot of shore line, the cost of the Coast Survey work has been economical.

In his report in 1849 the Secretary of the Treasury stated, as a general conclusion from the comparison with foreign surveys, that the work of the Coast Survey cost considerably less, and that in the case of the British survey a dollar nearly replaced a pound sterling in expenditure.

Professor Trowbridge's conclusion, Appendix No. 40, is to the same effect, from a recent and independent examination of the data of foreign surveys.

7. Compared in regard to the number of persons employed during a given time in the work of the surveys, the United States Coast Survey has accomplished its results with fewer persons.

The number of persons employed in the land parties of the Coast Survey was six-tenths of the number employed in the English survey in 1843, and four-tenths of those in the Irish survey.

The number of men in the hydrographic parties in 1857 was but three-tenths the number employed in foreign hydrographic work by Great Britain between 1843 and 1847.

8. In regard to opinions at home and abroad of the mode in which the survey has been conducted, a reference to authorities shows that—

(1.) Authorities connected with commerce and navigation have certified the practical usefulness of the work; have pronounced its execution efficient and its progress satisfactory.

(2.) Authorities of high scientific character, at home and abroad, have pronounced that the work is well conducted and on a level with the science of the day—indeed, tending to the advance of various departments of applied science.

The reports, memorials, and resolutions of the insurance companies and Marine Society of Boston, of the Chamber of Commerce and underwriters of New York, of the Board of Trade of Philadelphia, of the underwriters, ship-owners, and others, of the city of Baltimore, of the Chamber of Commerce of Charleston, are directly to the first point. Those of the Committee of the American Association for the Advancement of Science, of the American Academy of Arts and Sciences of Boston and Cambridge, of the American Philosophical Society of Philadelphia, of the Franklin Institute of Pennsylvania for the Promotion of the Mechanic Arts, of the Faculties of St. John's College, Maryland, and of the University of Virginia, are to the second point.

The extracts from the report of the Secretary of the Treasury (Hon. Thomas Corwin) in 1851, giving the testimony of Arago, Humboldt, Quetelet, and others, are to the same point. More recent testimony by the President of the Geographical Society of London, by Colonel James, and other distinguished scientific men, is given in the paper of Professor Trowbridge, Appendix No. 40.

The President of the Geographical Society of London in 1850 says: "I have studied the question closely, and do not hesitate to pronounce the conviction, that though the Americans were last in the field, they have (per saltum) leaped into the very first rank." In 1851 the President speaks of the work as "one of the most perfect exemplifications of applied science of modern times."

9. The space required to report the results of the several years of the survey, text and plates used as a rough indication, shows a great increase of work as compared with the increase of appropriations.

In 1844 twenty-one octavo pages sufficed to give a statement of the work done for the year, and it was shown upon three progress sketches.

In 1856 there were ninety-one pages quarto in the body of the report, two hundred and sixty-seven in the Appendix, and sixty-seven plates. Turning the pages quarto into equivalent octavo pages, the proportion of 1856 to 1844 is six-fold, and, including the Appendix, twenty-fold; the plates seventeen-fold. The results of the work are promptly communicated to the public through preliminary maps, charts, and sketches, and the more finished results (as directed by law) follow at a later day.

10. These reports are in demand not only on the seaboard, but in the interior States, both east and west.

The distribution list shows this clearly. Between one-seventh and one-eighth of the office distribution is in the six States of Ohio, Kentucky, Tennessee, Indiana, Illinois, and Missouri.

11. The records and results are promptly publishing under act of Congress so as to secure against loss, to prevent delay, and to insure the full information from and responsibility of those by whom the work is executed.

It has been the reproach of works of this kind that, while the results are furnished, the data upon which they are made up are not presented for scrutiny at all, or, if at all, so late that, for practical use, they have lost much of their value. The American Philosophical Society recommended earnestly the publication of the records of the Coast Survey, and on the recommendation of the department to Congress the publication was authorized and an appropriation made for the object in 1854–'55, and in the two subsequent years.

At the time of making the special report this work was in full progress. It has since been unavoidably suspended for want of the necessary appropriation to carry it on. This, it is hoped, as soon as the temporary exigency of the government is relieved, will be renewed, so that the publication may go forward.

12. The progress of the Coast Survey, as indicated by geographical limits, shows a great increase in recent progress over that of the earlier years.

In 1844 there were two centres of work, Narragansett and Buzzard's bays, and the coast of Long Island, Delaware bay entrance, and the upper part of the Chesapeake. A base of verification was measured at each end of the work; four sheets were published and six were in progress. In 1845 this work was extended eastward, and a new centre in Albemarle sound was also added. Eight general and harbor charts were published, and the important survey of the Gulf Stream was begun.

In 1856 the work on Section I reached Mt. Desert, Me.; the Kennebec and Casco bay were under survey; work was done north of Cape Ann and near Plymouth; Massachusetts bay was completed and progress made on the outside of Cape Cod, and further progress towards George's Bank in off-shore work. The difficult shoals in Nantucket sound and outside were finished. Six charts of this section were drawn and seven in progress, seven engraved and five in progress of engraving during the year. In Section II the resurvey of New York bay and harbor for the State commissioners was nearly completed, and the Hudson river work was extended both northward and southward. Several special surveys were made and a large number of drawings executed. The tidal observations were numerous and systematic. One chart was engraved and two more were in progress in this section. In Section III the work on the rivers of Virginia was nearly completed, and that on the seacoast and the approaches and interior of the Chesapeake advanced. Magnetic observations were made, some charts of localities in this section were in progress of drawing, two were engraved and five in progress of engraving. In Section IV the connection of Cape Henry was made in a preliminary way with the work of Section III. At the middle centre the work advanced southward to within twenty miles of the Cape Fear. The work from the Cape Fear centre was pushed southward into the next section. Four charts of this section were drawn, three were engraved, and four in progress of engraving. In Section V the northern work was carried south to Lockwood's Folly, the middle work to the Hunting Islands, and the southern centre work over Sapelo, St. Simon's, and Turtle river, and part of Cumberland sound. The hydrography from Charleston to Tybee was also completed. Six charts were drawn, five of them were engraved, and one was in progress. In Section VI the St. Mary's work was in progress, the triangulation of the keys and reefs of Florida was advanced eastward and westward to within one season of a junction, and the hydrography was carried eastward to Grecian shoal and westward to Loggerhead Key. Off-shore soundings were made from Tybee to Cape Cañaveral, and temperature observations continued in the Gulf Stream. Two charts were drawn and three were in progress, and three were engraved. In Section VII the work from the Cedar Keys centre was extended southward; St. Mark's harbor was completed; Apalachicola and Pensacola begun. Deep-sea soundings were made, and others for temperatures. Two charts were drawn and two engraved during the year. In Section VIII the work was extended westward of Mississippi sound, being completed to Pass Christian and Pearl river. Macon and Montgomery were connected for longitude by telegraph, the Chandeleur sound work and the off-shore hydrography were advanced, and Atchafalaya bay and Côte Blanche bays were under survey. Five charts of the work in this section were drawn during the year and four were in progress. In Section IX the land work of Matagorda bay was nearly completed, the hydrography outside made some progress, and one chart was drawn and engraved.

In Sections X and XI the work from the several centres made good progress. San Francisco bay was nearly completed. Anacapa and part of Santa Cruz island were completed, and other work of the Santa Barbara channel and islands executed. Cortez shoal was examined, San Diego harbor resurveyed, tides and currents observed. Nine charts were completed during the year, three were engraved, and five in course of engraving. Sixty-seven maps, charts, and sketches were published with the report of that year.

The increase of the appropriation is simply the means of working more economically, and of sooner accomplishing a desirable result. The great outlay for the survey ceases as soon as fixed points are determined once, and the whole work has once been gone over, by which any changes may be readily determined without going into a general survey again or elaborate operations.

13. The comparison of progress and expenditure shows that the work on the larger scale of the present system is more economical than on the smaller scale of the former progress.

The statistical data, founded chiefly on the extent of shore line, show that the progress in 1855, when the work had taken its present proportions of progress and expenditure in the three principal operations of triangulation, topography and hydrography, ranged from nearly two and a half times the average progress during the earlier years of my superintendence, namely, between 1844 and 1849. The progress of office-work was in a higher ratio. Making a liberal allowance for the progress on the Western Coast, the proportionate progress on the Atlantic and Gulf of Mexico coasts in 1855 is at least two and eight-tenths times (2.8 to 1,) the average between 1844 and 1849. The expenditure for the same coasts was, on the average, \$116,000 during the first five years named, and \$260,000 in 1855, (calendar year,) or less than two and three-tenths (2.3 to 1) of the former. The economy was five-tenths in two and eight-tenths, or eighteen per cent., and this leaves out many things which would give a much higher ratio, as will be seen from the statement of Professor Trowbridge, to which I shall now refer.

In passing to Professor Trowbridge's comparisons, which take in the period before my superintendence, I would observe that the proportion of one of the operations to the other parts of the work has been diminished purposely, the topography not being carried so far inland, partly in consequence of the objections urged in the discussion in Congress to this extent of topographical detail, and partly from the different character of the southern coast, where the larger proportion of the recent work has been carried on. The paper by Professor Trowbridge, Appendix No. 41, shows that, considering all the expenditures of the survey from 1832 to 1844, and from 1844 to 1856, twelve years in each, "the expenditures for the last twelve years * * * * amounted to about four times the expenditures of the preceding twelve years; and it is shown that the field work during the last period was about 7.3 times greater than for the preceding period, the office work being more than ten times greater. Taking the field work for the comparison, which is the least favorable, we have the following result: From 1832 to 1844, expenditure 1, work done 1; from 1844 to 1856–'57, expenditure 4, work done 7.3.

"This comparison, for an interval of twelve years, supposing the increase in expenditure and results to be gradual, gives an annual increase of expenditure of thirty-three (33) per cent., and for the annual increase of work done sixty (60) per cent., showing a gain in economy of twenty-seven (27) per cent.

"It is thus seen that while a gradual increase in the Coast Survey expenditures has been found necessary in order to extend the benefits of the work to all parts of the coast at the same time, a vast gain in time and money has been effected."

Professor Trowbridge further shows that if the Western Coast expenditures and results be deducted, which is necessary to a fair view of the case, since the prices on that coast are so much higher than on this, the economy shows still more strongly.

With that deduction, "the comparison between the cost and results will be as follows, (for the Atlantic coast:) From 1832 to 1844, expenditure 1, work 1; from 1844 to 1856–'57, expenditure 2.7, work 6.5, which shows an increase of twenty-two per cent. per annum in the expenditures, and of fifty-four per cent. in the results—a gain of thirty-two per cent. in economy."

For further details see Professor Trowbridge's paper, in Appendix No. 41.

In these comparisons the enhanced prices of all supplies is not considered; nor is the fact that in the southern sections the wages and supplies are more costly than in the northern ones, to which the work was chiefly confined in the earlier periods; but the comparison is from the figures as they stand upon the record, the statistics being used to show the progress, and the appropriations to show the cost of the work.

14. The present scale of conducting the survey is just up to the wants of commerce and navigation. To diminish the scale would be to fall below those wants, to make the survey take more time and cost more money.

When the survey was upon its former small scale there was a constant complaint in Congress and in the country generally of its slow progress. The Executive and Congress felt this; and the subject being fully and fairly considered by the President and Treasury Department, and by Congress, the scale was enlarged to its present extent.

The various accredited bodies connected with commerce and navigation throughout the country have approved of the present scale of the work as at once effective and economical.

In every question of advancement of commerce and navigation ; in the questions of military and naval defence ; in the questions of lighting, beacons, and buoys throughout the whole coast, Atlantic, Gulf, and Pacific, the data of the survey are called for to give the necessary basis for investigation and calculation.

The constant calls for information from the archives, reaching eighty-one in 1857, show the demand for such data.

To specify some of the questions in regard to commerce and navigation : The question—can the Great Eastern, now built in Great Britain, enter our harbors—has been determined by reference to Coast Survey maps. Portland has been selected as the place of touching. It has been shown that New York is accessible to her from the Sound side, so that she can lie nearer to the city than Sandy Hook ; that she can enter the Chesapeake and reach a proper anchorage.

The discovery of Stellwagen's Bank, off the entrance to Massachusetts bay, has led to a vast improvement in the safety of the navigation of that bay.

The development of the Nantucket shoals, by which the light-boat has been placed, and navigation rendered comparatively safe, has been of vast importance to the commerce of the United States, and was not made one hour too soon, since one of our national vessels might have been lost with a precious freight but for the knowledge of a Coast Survey pilot, acquired in the survey of these shoals, and his presence at the right point of time and at that place.

The whole question of the growth of Sandy Hook into the main ship channel of New York harbor has been settled by our surveys. The question of the draught of the Cunard steamers has been settled by the Coast Survey discovery of Gedney's channel at New York. The question of the proper port of entrance of a great southern line of steam vessels has been solved by the Coast Survey ; and, in fact, the survey of the splendid harbor of York river, Va., was not made a month too soon. The question of the improvement of the Cape Fear and of Charleston and Savannah harbors turns upon our surveys. The question of a southern naval depot was decided upon the merits of the harbors brought out by our maps, as is shown by the discussion in regard to Port Royal, S. C., and Brunswick, Ga., in the Senate of the United States. The important communication across the peninsula of Florida by the air-line railroad ; the question of its harbors on the Atlantic, at St. Mary's, and at Cedar Keys and Tampa on the Gulf ; and of its communications coastwise from the north and east, and to the south and west, and with California, are determined for the most part from Coast Survey data, acquired not a year too soon.

The question of the improvement of Apalachicola harbor will turn upon our data.

The discovery of a new channel at the eastern end of Dog island, leading to a safe and commodious anchorage in St. George's sound, will bear an important part in deciding the future of this part of the coast.

The questions of the use of Mobile bay and of Ship and Cat island harbors for the entrance of the British packet steamers were decided by these data within a few months after the surveys of these important localities were made, and concerned all the Gulf States and the interior connected with them through the rivers.

The question of the growth of the delta of the Mississippi will be determined in the progress of the survey.

The question of the great communication across the continent from Galveston and of the improvement of the coast of Texas rests upon these surveys, which are, in fact, two years behind the demands of that question.

The whole commerce of the Western Coast of the United States has, in the view of her merchants and navigators, received the highest benefit from the reconnaissance maps of that coast and the surveys of the harbors. The discovery of red sand as a mark for the bar of San Francisco is of the highest importance.

In regard to the defences the chief engineer speaks in terms not to be misunderstood. The modification of the defensive works at New York, and of those at Mobile entrance, and the defences of San Francisco, may be cited among many instances of the value of these surveys.

The improved light-house system has availed itself of the Coast Survey data in regulating the positions and number of lights and in determining their necessity; also in placing beacons and buoys. The Florida reef has been rendered comparatively safe by the beacons, places for which were pointed out by the survey, by the anchorages found, and the charts presented to navigators. The loss of one large vessel on this reef, avoided by our chart, according to the testimony of the captain, would have covered most of the cost of the Coast Survey for one whole year.

15. The list of developments and discoveries made by the Coast Survey parties, in their soundings and examinations, shows in a striking form the utility of the Survey to commerce and navigation.

This list (Appendix No. 9) includes at present no less than a hundred and fifty items, and shows how very necessary it was to the mariner to be made acquainted with the dangers and facilities to navigation thus developed. The list contains developments on every part of the coast which has yet been under survey.

16. The enormous losses by marine disaster, as well of life as of property, should be diminished by every proper means, and one of the most effective of these is by providing accurate charts of the coast.

In 1855 about four hundred and thirty lives were lost upon our coast, and property to the value of $11,850,000. The increase of tonnage yearly is about ten per cent. Interesting statistics of wrecks, obtained by Professor Trowbridge from the underwriters at New York, are stated at the end of his paper, (Appendix No. 40.) That the tendency is to diminish the risks of navigation is well known to the underwriters. The case of the Florida reefs is directly in point. By the erection of beacons resulting from the surveys, the publication of sketch maps as the survey was going on, and other circumstances not necessary to state, the number has been diminished and the character of the wrecks has been changed. In three years, from 1844 to 1846, there were, on the average, thirty-seven wrecks upon the Florida reefs, while in three years afterwards, (1854 to 1856,) notwithstanding the increase of tonnage, there were but thirty-five wrecks on the average.

The increase of tonnage would have made the proportional number forty-nine. The proportional losses, too, were much diminished.

17. In determining the scale and mode of executing the Coast Survey it should be considered that the work is a temporary one, having a limited object—the surveying of a definite extent of coast.

The survey of the coast having been once determined upon, there is a definite amount of work to be done, and the problem is to execute that with the greatest economy and despatch consistent with the resources of the government. The increase of the appropriations provides for the more rapid completion of the work, and terminates, therefore, all expenditure at an earlier date. It is not like the increase of a government expenditure for a permanent department, where an enlargement of expenses remains, and year by year must be constantly provided for, but this provides for its own completion at a day so much earlier as the means are more abundantly furnished, and, in fact, as experience shows, in a greater proportion than this.

18. While other compensations under the government have been considerably increased those of the officers of the Coast Survey have, on the average, been diminished, indicating a close economy in this branch of the public service, where the salaries are fixed by the Treasury Department itself. This is notwithstanding the enhancement in price of everything in the country which has occurred during the period referred to.

DEVELOPMENTS AND DISCOVERIES.

The general list up to 1857, inclusive, is given in Appendix No. 9, and contains one hundred and forty-two references to matters geographically arranged. The following is a list for the last year :

1. Fishing ledge off Kennebunk, Maine, thoroughly sounded.
2. A rock one mile to the southward and westward of Boon island, with seventeen feet water. The sea breaks on it in heavy weather.
3. Development of Boon Island ledge, coast of Maine.
4. A rock off Cape Neddick, Maine, determined in position.
5. A detached rock, two-thirds of a mile northward and eastward of York ledge, Maine.
6. Determination of the position of a rock more than a mile off the mouth of York river, Maine, bare at low tide and dangerous to coasters.
7. Development of Duck Island ledge.
8. A very dangerous rock, with only six and a half feet water, off the entrance to Portsmouth harbor, N. H., about four nautical miles eastward from the Whale's Back light.
9. A rock, with twelve feet at mean low water, about a third of a mile eastward of that just described.
10. An extension of the sand spit to the southward of Sunken ledge, Boston harbor, since the survey of 1847.
11. Luddington rocks, determined in position, about ten yards apart, a mile and a half (nautical) S. W. by compass, from New Haven light-house.
12. Tidal currents in East river, New York, and surface and sub-currents investigated in New York harbor, the lower bay, and on the bar.
13. Changes of shore-lines and hydrography determined at the Cape Fear entrances, N. C.
14. Increase of depth developed in Maffitt's channel, Charleston harbor, S. C.
15. A new channel into St. George's sound, (Apalachicola, Fla.,) at the east end of Dog island, and anchorage connected with it.
16. Shoals near the east and west passes of St. George's sound, (Apalachicola, Fla.,) and a new channel between St. George's and St. Vincent's islands.

17. Whiting's rock, determined in position near the "Brothers," at the entrance of San Pablo bay, Cal.

18. A reef developed off the Contra Costa flats, San Francisco bay, Cal.

19. A bank of three and a half fathoms, about a mile off the S. W. point of Sucia island, at the northern entrance of Washington sound, W. T.

Notices of several of these developments and discoveries are given in the Appendix, Nos. 10 to 18, inclusive.

The most important one is the discovery by Lieutenant Commanding Duer of the eastern channel into St. George's sound, (Apalachicola.)

I have not thought it necessary to repeat the table of depth of channels, bars, &c., given in my last report, deeming a publication, with additions, once in two years sufficient.

The reports to which I have just referred as in the Appendix contain statements of interest in refuting or admitting suggestions in regard to facilities and dangers. I am indebted to Captain R. B. Forbes, to President Curtis, (through Messrs. Bond & Son,) and to G. W. Blunt, esq., for valuable suggestions in regard to examinations.

SURVEYS ON THE WESTERN COAST.

A list of surveys of capes, headlands, islands, harbors and anchorages, bays, reefs, banks and shoals, straits and entrances, rivers, cities, and towns on the Western Coast is given in Appendix No. 7, and includes one hundred and ten titles. The work has closely followed the development of that important part of the coast of the United States. The aid required under the law to the Northwest Boundary Commission has necessarily retarded the hydrography there during the past year. The survey of the Western Islands, too, is continuing from a balance of the former appropriation, no new appropriation for 1858–'59 having been made.

DIRECTORY FOR THE PACIFIC COAST.

This useful work (Appendix No. 44) has been compiled by George Davidson, esq., assistant in the Coast Survey, from the Coast Survey and other authentic data, embodying also the results of his own experience on the coast, where he has been occupied in charge of geographical, triangulation, and topographical parties since the commencement of the survey in 1849. Having thoroughly and peculiarly identified himself with the survey of the Western Coast from its beginning, and had occasion himself to know the necessities, facilities, and dangers of its navigation, he has been in a position to prepare a particularly valuable directory for the use of mariners and navigators.

Mr. Davidson was one of the pioneers of the Coast Survey on the Pacific, and the oldest of the party (George Davidson, John Rockwell, and James S. Lawson) who undertook, upon the slender resources of the survey and under the difficulties incident to the recent discovery of gold in that region, to carry forward the work. Lieutenant William P. McArthur, United States navy, to whose energy and enterprize we owed the first reconnaissance chart of the coast, did not live to return to the Atlantic States with the results of his labors. These have been perfected with more ample means by Commander James Alden, whose name, with those of Lieutenants Bartlett, MacRae, Cuyler, and others, is honorably associated with the advance of the hydrography of the Western Coast, from Lower California to the British possessions.

On the Pacific coast the Directory will pass into the hands of the officers of the navy and navigators generally, and any errors or inadvertencies which may exist (and in such an extensive work they must almost necessarily occur) cannot escape criticism. This Mr. Davidson frankly and unhesitatingly admits. The credit of an elaborate, important, extended, laborious work like this cannot be, even in the least degree, impaired by slight imperfections in detail.

The general plan of the Directory is, to give a description of the bay, harbor, portion of the coast, its leading features, the history of its discovery, with notes of the previous maps and charts, and remarks of the earlier navigators, and a comparison, sometimes, of existing characteristics with those assigned in earlier times. The facilities for navigation, geographical position, and magnetic variation follow, with sailing directions for entering the bay or harbor, or passing along the coast. The leading features of the tides are given. General remarks close the paragraphs, each of which is headed with the name of the portion of the coast described in it. References are added, giving the dates of the Coast Survey charts of all the localities for which charts have been published.

SPECIAL SURVEYS.

progress made in the survey for connecting the triangulations of the Atlantic and Gulf of Mexico by an air line across the head of the peninsula, is stated under the head of Section VI. I remarked last year that another appropriation of ten thousand dollars would be required to complete this work, if that sum only were granted for the fiscal year 1858–'59. I have yet had no reason to change this opinion, and have therefore asked five thousand dollars for the next fiscal year for the work. It is probable that a second appropriation of the same amount may be needed to complete it.

In prosecuting the special surveys for the General Land Office of the Florida main and keys, the main at Cape Sable has been connected by triangulation with the keys, and two topographical parties have been engaged between Key Largo and the Vacas, marking those keys which contained fast land, according to the scheme approved by the Land Office. My report on this subject to the Commissioner is in the Appendix, (No. 35,) accompanied by extracts from those of the assistants occupied in the surveys. One more year would have completed this work had the appropriation been continued.

INFORMATION FURNISHED.

The list of items of information furnished, under the regulations of the Treasury Department, from the archives, is given in Appendix No. 6, and includes seventy-two communications of more or less importance, some of them consisting of several tracings of maps. An application to the Secretary of the Treasury is needed as a security in case of non-compliance with the simple conditions exacted by the department.

STATISTICS.

Of the field and hydrographic parties, a considerable number is either at work at the end of the surveying year, or about being transferred to the southern sections; and it hence follows, of necessity, that a part of the *office-work* is left outstanding when my annual report is made up. The statistics heretofore given were taken from such data as were in the office when my yearly reports were presented to the department to be laid before Congress ; and from varying exigencies incidental to that period of the season, unequal portions of the office-work were in consequence omitted. In some cases, moreover, the return of records, &c., was unavoidably delayed or postponed by the immediate reassignment of the same parties to other field duty.

Within the year the table of statistics has been thoroughly revised by reference to the aggregate journals, charts, topographical sheets, and other data now in the archives, and the particulars distributed to the dates to which they respectively belong. The result (Appendix No. 8) is satisfactory, and shows, as might be expected, a gain in the rate of progress in the prosecution of the field-work.

MAPS AND CHARTS.

The details of progress, in reference to maps and charts, are given under the head of office-work in the closing chapter of this report. In my report of last year I explained the plan which had been adopted for a series of preliminary charts of the coast on a scale of $\frac{1}{200000}$, and for two sets of finished maps and charts, one with coast topography and in-shore hydrography on the scale of $\frac{1}{80000}$, and the other, general coast charts with both the in and off-shore hydrography on the scale of $\frac{1}{400000}$. I stated at the same time the progress made in the several classes, and the materials already in the office for the series. Besides these three classes are the numerous harbor maps and charts published or in progress.

The study of the $\frac{1}{80000}$ coast maps and charts has been completed during the year as far as is practicable, before the minute surveys of all the localities are made. They are a hundred and thirteen in number, formed into sets or series, (Sketch No. 40,) so as to include some of the principal highways of commerce on the same series, beginning and ending at ports connected in commercial relations and navigating interests. Of these, twenty-seven are in progress of drawing or engraving, fifteen having been already completed. The materials for beginning twenty-eight are in the office. The Atlantic coast will be given in sixty-seven sheets, constituting twenty-four series. The first series extends from Calais, Maine, to Penobscot bay, and is divisible into two sets of two sheets each ; one from Calais to Eastport, the other from Eastport to the Penobscot.

The second extends from Bangor, Maine, to Portland ; is also in three sheets and divisible into two sets, one including the Penobscot river and bay from Bangor to Rockland ; the other from Penobscot entrance to Portland.

The third series, in three sheets, extends from Cape Elizabeth (Portland) to Cape Ann, (Gloucester, Mass.)

The fourth series, in two sheets, extends over Massachusetts bay.

The fifth, in three sheets, from Nantucket to Point Judith.

The sixth and seventh, each, in three sheets, over Long Island Sound and the south side of Long Island.

The eighth, one sheet, over New York bay and harbor and the approaches.

The ninth, in three sheets, along the coast of New Jersey.

The tenth, in three sheets, includes Delaware river (from Trenton) and Delaware bay.

The eleventh, the peninsular seacoast of Delaware, Maryland, and Virginia.

The twelfth and thirteenth, each in three sheets, cover the Chesapeake; one series extending from the head of the bay to the Potomac, and the other from the Potomac to the entrance.

The fourteenth series, in three sheets, extends from Cape Henry to Cape Hatteras.

The fifteenth and sixteenth, each in two sheets, cover Albemarle and Pamplico Sounds, the minor sounds connected with them, and the entrances to the rivers.

The seventeenth series, in two sheets, extends from Cape Hatteras to Cape Lookout.

The eighteenth, in three sheets, from Cape Lookout to Cape Fear.

The nineteenth series, in three sheets, reaches from Cape Fear to Winyah bay.

The twentieth, from Winyah bay to Tybee entrance, (Savannah river.)

The twenty-first, in four sheets, from Tybee entrance to the St. John's.

The twenty-second, in four sheets, from the St. John's to Cape Cañaveral.

The twenty-third, in two sheets, from Cape Cañaveral to St. Lucie Inlet.

The twenty-fourth, in three sheets, from St. Lucie Inlet to Cape Florida, terminating the Atlantic coast.

These sixty-seven sheets will be generally of the same size, namely, twenty-five by thirty-five inches; and all may be bound into the same atlas of the Atlantic coast.

The Florida channel and Gulf of Mexico coast will be given in forty-six sheets, constituting seventeen series. The sheets are of the same size as for the Atlantic. Continuing the numbers heretofore referred to:

The twenty-fifth series, in four sheets, extends from Cape Florida to Key West.

The twenty-sixth, in two sheets, from Key West to the Tortugas.

The twenty-seventh, in two sheets, from Cape Sable to Cape Romano.

The twenty-eighth, in three sheets, from Cape Romano to Tampa bay.

The twenty-ninth, in three sheets, from Tampa bay to Cedar Keys.

The thirtieth, in two sheets, from Cedar Keys to St. Mark's.

The thirty-first, in two sheets, from St. Mark's to Apalachicola.

The thirty-second, in two sheets, from Apalachicola to St. Andrew's bay.

The thirty-third, in two sheets, from St. Andrew's to Mobile.

The thirty-fourth, one sheet, covers Mobile bay.

The thirty-fifth, in three sheets, extends from Mobile entrance to New Orleans.

The thirty-sixth, in six sheets, two of which are the same as two in the last series, embraces the approaches to New Orleans.

The thirty-seventh, in two sheets, extends from Timballier bay to Atchafalaya bay.

The thirty-eighth, in three sheets, from Atchafalaya to Calcasieu bay.

The thirty-ninth, in three sheets, from Calcasieu to Galveston bay.

The fortieth, in three sheets, from Galveston to Matagorda entrance.

The forty-first, in three sheets, from Matagorda to Corpus Christi bay.

The forty-second, in three sheets, from Corpus Christi to the Rio Grande.

Materials for beginning twenty-nine of these series (more than half) are already in the archives. These, it will be remembered, are to be finished maps resulting from the survey.

In the Drawing Division, seventy-eight sheets have been worked on during the year, forty-seven of which have been completed, and thirty-one are in progress. Of the number completed, eleven are finished maps, four preliminary charts, three comparative charts, twenty-six are sketches, (including fourteen progress sketches,) and three are sheets of diagrams.

Eighteen of the drawings in progress are finished maps, four are finished charts, three general coast charts, and eight are preliminary charts.

In the Engraving Division, six first class maps have been completed during the year, and twenty have been in progress. Of these last, twelve were commenced in former years and eight in the present year. Sixteen second class maps or charts and sketches have been completed within the year; twelve of which were begun in the present year, and four of the same class, commenced within the year, are in progress. Six diagrams have been completed. This gives a total of twenty-eight plates completed, and twenty-four in progress, or of fifty-two engraved or engraving within the year ending October 1. In addition to those engraved upon copper, twenty-one charts and sketches have been engraved upon stone, under the direction of the Superintendent of Public Printing. The complete list, giving the titles of the maps and charts, will be found in Appendix, No. 19. The list of maps, charts, and sketches, up to the present date, also accompanies this report, and will be found in the same Appendix. It includes two hundred and eighty-six titles, of which fifty-eight are of first-class or finished maps. In addition to these, twenty progress sketches have been engraved.

PRELIMINARY SEACOAST CHARTS, GENERAL COAST CHARTS, OR OFF-SHORE CHARTS.

The notice of the preliminary seacoast charts and of the general or off-shore charts, in my last report, was so full, that it is not necessary to do more at present than to say that the work upon them has been systematically pursued. Of the thirty-three preliminary charts, fourteen are in progress of drawing or engraving or have been completed, and three have been superseded by finished maps, and of the general coast charts, three are now in progress.

LONGITUDES.

The law of 1844, reorganizing the Coast Survey, provided that it should be executed according to a plan to be submitted to the President of the United States by a board of officers therein designated. The work has been successfully carried on under that plan from its early stage until now it is, on the Atlantic, more than two-thirds done, and on the Gulf of Mexico more than one-half done, and the plans for its completion are so fully developed as to show that merely steady progress in the direction already fixed is needed to insure a successful completion within a limited period.

Prominent among the provisions of the plan was the following: "At the most favorable points of this main series [of triangles] observations shall be made for the determination of latitude, longitude, and azimuth, and also such magnetic observations as circumstances and the state of the annual appropriations may allow. It is also urged, and deemed essentially necessary, that the difference of longitude between some main points of the survey and the meridians of any or all of the European observatories be ascertained immediately."

The first directions issued by the Treasury Department for the survey under my superintendence, in 1844, provided for the execution of this work as follows:

"Astronomical and magnetic observations, in addition to those already specified, will be made at suitable points within the limits of the survey, as directed in Art. I of the plan for the reorganization of the survey of the coast. The difference of longitude between some well determined European observatory and a point connected with the survey will be determined as soon as practicable.''

At that time astronomical observatories and the transportation of chronometers furnished the only means of determining the longitudes. In my report of 1844 I describe the steps taken to carry out the directions, and refer to the observations of occultations and moon culminations made for the Coast Survey at Cambridge, by W. C. Bond, esq., and at Philadelphia, by Prof. E. O. Kendall, to the computations of Prof. S. C. Walker, who had charge of this branch of the subject, and to those of Prof. Peirce, of the Cambridge observations of four years between 1831 and 1840. At the same time an arrangement was made with Mr. Bond for reporting the results of difference of longitude between Liverpool and Boston as determined by the chronometers of the Cunard steamers.

The collection of astronomical observations, including those of eclipses, occultations, and moon culminations, and of chronometer results, was continued, and my reports each year show the progress made, and in 1845 Prof. Walker made an elaborate report upon this subject, showing how it was to be continued. In my report of 1847 his labors are thus spoken of: ''The labors of Mr. Walker are directed to the following points: 1st. To make for the Coast Survey as extended a collection of astronomical observations, bearing upon the longitude, as practicable. 2d. To preserve throughout, in the reductions, uniformity of method. 3d. To present in successive annual reports, or when specially called upon by the Superintendent, the best data for the longitudes of cardinal points which the tables and catalogues of the day enable him to furnish. 4th. To preserve the computations, and so to arrange the equations of condition which they supply, that any subsequent modification of the data may be readily applied. The determination of the longitude of a cardinal point in the Coast Survey, by comparison of observations in the United States and Europe, with a degree of precision at all comparable to the results of the geodetic part of the survey, is a work of great difficulty. The object of Mr. Walker's labors is to bring to bear so large a number of results that any new or isolated efforts cannot sensibly alter the conclusion or impair confidence in it. The importance of this will be obvious to all who are acquainted with the difficulties encountered in fixing, in other national surveys, the geographical position of the central meridian.''

In 1848 Mr. Walker, then an assistant in the Coast Survey, and devoting his whole time to the work, made his elaborate report, in which, with remarkable sagacity, he anticipated so many of the causes of error of the lunar tables, a part of which had already been stated in 1845. This report also urges the discussion of all the occultations of the Pleiades previously suggested by Bessel.

In 1846 the completion of several telegraph lines gave a new impulse to this subject, and under Mr. Walker's immediate direction the American method of longitudes was rapidly developed in connection with the survey of the coast. In this work the ingenuity and labors of Messrs. Saxton, Bond, Mitchel, Locke, Loomis, and others, were brought to bear, under Mr. Walker's impulse, upon the various problems which early developed themselves in connection with telegraph longitudes.

The intrinsic difficulties in the astronomical methods, so strongly urged by Mr. Walker, led us to look more closely to the chronometric results, and having obtained all the fruit from the use of the chronometers of the steamers of which these determinations were capable, our attention was turned to special expeditions, in which the instruments would be exclusively under the control of agents of the Coast Survey. In 1849 and 1850 the first expedition was organized and placed under the direction of Professor W. C. Bond, of Harvard observatory, and "the first mean result, derived from one hundred and seventy-five chronometers," was deduced by him and reported. A second expedition, in which the experience of the first was used to improve the methods, was carried on in 1851 under the same immediate direction, the number of chronometers having been increased to one hundred and ninety, and the instruments having been, most of them, specially prepared for use in the expedition. The results obtained in 1849, 1850, and 1851, were reduced by Geo. P. Bond, esq., who reported the result in 1854.

This year (1851) Mr. Bond reports that, "According to your instructions I have made preliminary arrangements for the connection in longitude, by means of the electric telegraph, of the British surveys of the Bay of Fundy and Gulf of St. Lawrence with the United States Coast Survey. Commander Shortland writes me that he will be in readiness to meet us at Halifax the beginning of November." The observations were brought to a close in December, 1851, those between Cambridge and Bangor in connection with them being under charge of Professor S. C. Walker.

The evidence being deemed conclusive that the variation of temperature in the chronometers seriously affected the results previously obtained, a new expedition was undertaken, preceded by the investigation of the effect of temperature upon the chronometers. This, also, was under the charge of Professor W. C. Bond, whose report is given in mine of 1855.—(Appendix No. 43.)

Geo. P. Bond, esq., by the method of least squares, gave for the difference of longitude of the Liverpool and Cambridge observatories, $4h.\ 44m.\ 31.89s. \pm 0.19s.$ For the first time the voyages east and west gave sensibly the same result.—(Appendix No. 23, 1856.)

In 1852 Professor Peirce, of Harvard, undertook the subject of longitude computations, and on the decease of Professor Walker, in 1853, Dr. B. A. Gould, jr., took charge of the telegraph operations and the computations depending upon them.

The method of the Pleiades was revived by Professor Peirce in 1855, (Appendix No. 42, Superintendent Coast Survey Report, 1855,) and diagrams of the occultations have been distributed to the observatories in the United States and in Europe, which were invited to observe and transmit the observations to the Coast Survey Office.

The telegraphic methods were steadily in progress, and through the liberality of the officers of the different telegraph lines every facility was had for extending the chain of longitudes from Washington southward and westward and northward and eastward. The introduction of repeaters into the different lines required the use of numerous stations in the general chain. By the kindness of the directors of the New York, Newfoundland, and London Telegraph Company, in 1857, facilities were extended to us between Bangor and Calais, Maine, and the arrangement with the provincial lines inuring to our advantage a station was put up at Sackville, New Brunswick, near the Bay of Fundy, in 1857, with a view to connect that point, where there is a repeater, with Calais on the one side, and with the Newfoundland telegraph station at Trinity Bay, so as to be prepared, in case the Atlantic telegraph cable was successfully laid, and a connection through it was practicable, to connect our longitude with Valentia, in Ireland, already connected with Greenwich by the Astronomer Royal.

It will be seen by this brief account that the subject of longitudes has been expressly enjoined upon the Coast Survey by law, for the purpose of determining the "difference of longitude of some main points of the survey and the meridians of any or all of the European observatories." The Treasury Department has, in its annual directions, never lost sight of the importance of this problem. The work has been assiduously prosecuted by the various methods known when the direction of the law was issued, and a new one has been successfully introduced and brought to a high state of perfection. Repeated assurances have been given me by the honorary directors in the United States that, in the event of the successful connection by telegraph with Europe, the Coast Survey should have the first use of it for longitude purposes. The progress which has been made in the execution of the law has been satisfactory, and requires only the opportunity to transmit telegraph signals to make it complete. The necessary instruments for the application of the "American method" are on hand, in their most complete form; the observers are trained to the method, and are regular officers of the Coast Survey. All the conditions of the problem are well understood, and we are in a position to carry forward, economically and efficiently, our work thus elaborately begun and steadily continued, to a successful close.

LONGITUDE BY OCCULTATIONS OF THE PLEIADES, SOLAR ECLIPSES, AND MOON CULMINATIONS.

The arrangements for observations of occultations of the Pleiades by the moon have been continued under the direction of Professor Peirce.

The predictions for March 19, August 3, August 30, September 26, October 24, and December 18, were computed by Mr. Edward Pearce, jr., and were projected in the Coast Survey Office and distributed to the different observatories in this country and abroad.

The list now embraces thirty stations in America, and a like number in Europe.

Observations of the occultation of December 27, 1857, have been received from ten stations, including two foreign ones. Of the occultations of this year we have, for March 19, observations at seven American; for August 30, at three European, and for September 26, at two American observatories.

Observations of moon culminations, occultations, and of a solar eclipse, have been made for the Coast Survey at Harvard College observatory under the direction of Professor W. C. Bond, (see Appendix No. 22,) and observations of moon culminations at the Cincinnati observatory, under the direction of Professor O. M. Mitchel.—(Appendix No. 23.)

A new method of computing longitude from moon culminations, originating with Professor Peirce, is given in Appendix No. 21. The method takes advantage of the recent improvements in the lunar tables, and saves much labor by substituting the use of the hourly lunar ephemeris for an interpolation by fourth differences from the list of moon culminations.

Longitudes by the telegraphic method.—We have this year completed the connection of Washington and New Orleans by filling up the gap between Mobile and New Orleans. The meridians of Albany and New York have also been connected. The particulars of the work are given in the chapters on Sections VIII and II, respectively. Incidentally the longitudes of a number of important places have been determined, where the repeaters introduced in the telegraph lines required the establishment of a new station. The opportunity was used to determine the latitude and magnetic elements of the same places with but a trifling additional expense.

As the telegraph lines are extended this admirable method will be pushed onward. We have a station at Sackville, N. B., for the purpose of connecting with the Nova Scotia survey, the connection being only partially effected in 1851. The places connected by longitudes determined in this way, namely: Calais and New Orleans are twenty-two and three-quarter degrees of longitude and fifteen and a quarter degrees of latitude apart, and in an air line one thousand six hundred and twenty-one miles.

LATITUDES BY THE ZENITH TELESCOPE.

In the Appendix to my report of last year I gave a valuable paper, by Assistant Charles A. Schott, on the use of the zenith telescope for determining latitude by Talcott's method. Certain observations made in 1853 seemed to indicate that this method was not free from objection, on account of the personal error of the observer, or special error of the instrument, or that two observers, with the same or different instruments, and observing the same pairs of stars, would not obtain the same latitude. This subject has been made one of careful study, the observers and instruments having been changed so as to vary the circumstances of observation. The result is highly satisfactory, for it turns out that there is neither "personal equation" of observer nor of instrument.

A probable accidental error of from one-quarter of a second to a second of space may be expected from one observation upon a pair of stars used in this method, according to the size and quality of the instrument and the skill of the observer. The probable error of a latitude result, from the errors in declination of a single pair of stars as given in the catalogue, ranges from six-tenths of a second to one second. So that a latitude from thirty pairs may be expected not to vary more than from eleven-hundredths to eighteen-hundredths of a second from the truth.

The details of results, with the names of the assistants who have co-operated in obtaining them, are given in Appendix No. 20.

MAGNETIC RESULTS.

While observing the variations for nautical purposes, it is easy to add the other important magnetic data of dip and intensity, and such has been the system adopted.

As the work is extended new stations are occupied, and every two years the data for these additional stations are given in my annual report. The maps of magnetic lines which have resulted from these investigations have also been given with my reports.

During the past two years twenty-eight additional magnetic stations have been occupied, spread over the Atlantic, Gulf, and Pacific coasts. The table, Appendix No. 24, gives the place, the latitude and longitude, the declination, (variation,) the dip, and the horizontal magnetic intensity, the date of observation and remarks. The whole number of points at which observations have been made, chiefly in connection with the triangulation, is a hundred and eighty-three.

The annual reports have contained a valuable series of papers, by Assistant Charles A. Schott, on the gradual changes of the magnetic elements, (secular changes.) Two new contributions by the same officer are given in the Appendix Nos. 25 and 26, the first being a rediscussion by which he has developed the existence of an intermediate period of about eighty-eight years within the period of two hundred and thirty-four years, in which the secular change of the magnetic declination is completed at Hatboro', Pennsylvania.

The observations are so closely represented as to leave an error of observation of only $\pm 5'.2$. The maximum declination occurred in 1796.3, and its present annual westerly increase is $4'.4$. This latter quantity will reach its maximum ($4'.6$) in 1875. The second paper (Appendix No. 26) discusses the secular change of the magnetic declination (variation) and dip at Washington city.

The magnetic declination was least at about the close of the last century, (1797.6, with a probable uncertainty of 1.8 year,) and the probable duration from least to greatest is two hundred and thirty-seven years, with an uncertainty of several years. The improved formula for expressing the declination at any date is still very simple, and gives results according closely with the observed ones, not differing more than a third of a degree in any case. Its differentiation gives for the annual change at this time 3.1 minutes, increasing westwardly. At the close of the last century the line of no variation passed below Washington and above Norfolk. The greatest declination will probably be west $4^{\circ}.4$.

The formula for the dip retains the form before given to it, but the co-efficients are improved by the new data, and the dip may be computed from it between 1839 and 1858 with no greater error than two minutes and a half. The present annual change is about 1.2 minute, and the minimum of dip occurred in the summer of 1844.

TIDES AND CURRENTS.

Regular observations of the tides have been kept up on the Atlantic coast at Boston, New York, Old Point Comfort, Charleston, and St. Mary's; and on the Pacific coast at San Diego, San Francisco, and Astoria. The observations are systematically reduced as they are received, and the report of the chief of the tidal division, Assistant Pourtales, Appendix No. 29, gives a complete list of them, and states the progress made in their reduction. The Boston series extends now through more than eleven years, during which period the registry of not more than half a dozen tides has been missed. All the stations, except Boston, are furnished with Saxton's self-registering gauges; but at New York the winter observations still require the use of the common gauge. The discussion of the tides of the Florida reef showed that observations for a longer period were necessary there, and four stations have been occupied between Cape Florida and the Tortugas for a year. The gauges have now been removed to the western coast of the peninsula, to Charlotte harbor, Tampa bay, and Cedar keys, the Tortugas station being kept up to connect the two series.

An interesting series of observations has been made in San Francisco bay to develop the curious changes which the tide wave undergoes, especially the diurnal wave in that bay and its dependencies. These observations will be more particularly noticed under the head of the hydrography of Section X.

The changes in the co-efficients of the tidal formula from year to year have yet baffled us in obtaining all the accuracy that is desired for prediction tables. We are constantly at work, however, upon the problem.

The tide-tables and tide and current memoir prepared by me have been revised in the tidal division for the report of this year, Appendix No. 43.

Tidal currents in New York bay and harbor, and the approaches.—A discussion of the tidal currents near Sandy Hook, from the observations of Assistant Henry Mitchell, is given in the Appendix No. 27. The general results have been heretofore stated in my reports, and the paper gives the numerical details with diagrams representing them, and the generalizations to which they have led. A sketch (No. 39) shows the places of the current stations which were selected so as to embrace the phenomena of False Hook and its channels ; of the point of the Hook and the ship channel passing by it ; of the western side of the Hook ; of Sandy Hook bay ; and of the western extremity of the main ship channel. The normal currents in the main ship channel are first discussed and referred to the tides ; and using these as a standard, the secondary currents of False Hook channel and its approaches, and of Sandy Hook bay, are described and traced to their sources. The shore currents which transport material to the extremity of Sandy Hook, and mainly cause its growth under water, are shown to prevail for more than seven hours out of twelve and a half, the velocity of the flood current being nearly a mile and a quarter per hour, while that of the ebb is five-eighths of a mile. This is the current which makes False Hook channel, and which has removed the bulkhead formerly existing off the northern point of the Hook, and the False Hook itself occupies the debateable ground between the outside currents (normal) and those of the shore, (secondary,) the difference of action being, in fact, defined by this shoal.

The obvious method of limiting the growth of the Hook by jettees is pointed out as of easy resort whenever the case may seem to require it.

The system of secondary currents in Sandy Hook bay is quite complex, varying at different stages of the tide, but may be clearly traced and understood by following the diagrams given in the memoir, (Sketch No. 39.) At certain stages of the ebb-tide the main current of the bay, that of the main ship channel, is merely deflected into Sandy Hook bay ; while at portions of the flood, the currents caused by the lateral communication of motion are entirely different from the normal ones. For example : about four hours after low water, while the current of the main ship channel is flowing westward, that of the eastern section of Sandy Hook bay flows to the north, and, near the Hook, with a velocity of one mile and four-tenths per hour. The shifting whirl, which begins at the point of the Hook about an hour after low water and extends in size as it moves to the southward and westward at a later period of the tide, and which is one of the most remarkable features of these currents, is traced upon the diagrams.

The estimate of work done in shifting material by the ebb current in the eastern part of the bay, to that done by the flood, is as high as forty-five to one ; while in the middle it is as nine to one. The form of the bottom is, of course, in general accordance with these results.

The general investigation in the harbor and approaches has been continued in the upper and lower bay of New York by the occupation of forty-seven stations.

The currents below the surface have been observed by an ingenious apparatus devised by Assistant Henry Mitchell. This consists of two large copper globes, as floats, connected by a slender cord, one weighted so as to float when immersed to the depth of four feet, and the other so as to sink to different depths in the currents which it may be desired to investigate. The motion of the apparatus will depend, of course, upon the difference of movement at four feet, the nearly superficial current, and below, so that, obtaining by the ordinary log the movement at the surface, that below becomes known by observing the motion of the apparatus itself. It has been tried also by balls with small stems or tubes, the balls being weighted so as to float at the desired depth.

Some very curious and useful results have already been derived from these observations, which, however, have not yet been fully discussed. For example: at a station between Governor's and Bedloe's islands the currents were observed at the surface, at 17, 42, and 68 feet, respectively, the depth of water at the station being 80 feet. The flood drift at 42 feet, and still more at 68 feet, greatly exceeds that at the surface in velocity and duration, while the ebb drift at 68 feet is very feeble, that at 42 feet being still considerable. During the course of the tide the axis of the drift or line of greatest movement changes its place considerably, rising and sinking.

The singular channel which connects Gedney's with the eastern channel, and the permanence of which has been quite a puzzle, will, it is believed, receive its explanation from these observations. Mr. Mitchell says:

"In that channel our apparatus indicated still water immediately below the general depth of the bar, (18 to 21 feet,) and yet at 40 feet we detected a slight counter drift creeping lazily along, entirely local, I think, in character. This counter drift is so feeble, and occupies such a thin stratum, that we could not measure it, and only found it on a moonlight night by seeing our white sinkers straggling away in an opposite direction to the surface drift. This channel, unlike any of the deep channels in its neighborhood, appears to be the work of the flood current, and depends for its existence upon the position and form of the Romer shoal, which is itself a deposit of the ebb."

The scope and importance of these researches will be seen from this brief notice. An appropriation was made at the last session of the legislature of the State of New York for their continuance. Another extract from one of Mr. Mitchell's reports will show their direct bearing upon the Coast Survey:

"I have already called your attention to what appears to be a constant drift pressing up towards the Long Island shore. I found such a drift off the eastern portion of Rockaway, and the observations at the light-ship show traces of it. I mentioned this to an intelligent ship master, who said it explained to him the cause of several remarkable wrecks. He mentioned the case of a ship bound eastward with a leading wind and holding a course by compass E.SE. The captain, certain of plenty of sea room, went below and turned in. The vessel struck on Fire island during the night."

Besides these results, supplementary observations in the eastern approach to New York, found necessary from the discussion of the previous ones, have been made. The references of the bench marks on the Hudson river, to the low waters, have also been regulated. Appendix No. 28 contains a general statement of the observations conducted this season by Assistant Mitchell.

A general discussion in regard to the origin of ocean currents, by Lieut. E. B. Hunt, Corps of Engineers, U. S. A., will be found in Appendix No. 31, and in No. 32 some interesting remarks by that officer, and facts collected by him bearing on certain anomalies observed in the Gulf current between the Florida peninsula and the coast of Cuba.

RECORDS AND RESULTS.

The exigencies of the times requiring a diminution in the appropriations for the Coast Survey, a part of the retrenchment fell upon the item for publishing the records and results of the work. No appropriation being made for these publications in the present year, it became a subject of grave question what course it was best to pursue in reference to them. After weighing the arguments, I determined to recommend that the persons employed in preparing the material of the records and results of the survey, who have acquired special experience in their work, should be retained and continue their labors, putting the material in shape for publication. That, in addition, such stereotyping should be done as the means disposable permitted, and the work be thus secured from possible loss, and be made ready for publication whenever the appropriations permitted. This is a better plan than to expend the balance of appropriation on hand in publishing what is prepared, and then to suspend the whole operation, waiting for additional means. It secures the continuity of the plan, and loses nothing which has yet been gained towards its complete execution. Under this view the geodetic volume, referred to in my report of last year as part of the series nearly ready for publication, will not at present appear. The question is still under consideration whether the volumes of Sailing Directions and the Gulf Stream observations may be published with the means already on hand, or whether their publication must also be suspended for the present.

The matter of records and results is continued under the immediate charge of Assistant J. E. Hilgard, who has devoted the chief part of his valuable time to it during the past year.

The arrangement of the Gulf Stream observations has been continued, under my immediate direction, by Professor W. P. Trowbridge, who has had the charge of preparing that portion of the work for publication.

INDEX OF SCIENTIFIC REFERENCES.

This work has made little progress since my last report, Lieutenant E. B. Hunt, of the Corps of Engineers, who was engaged in it, having been drawn entirely from the survey by his engineer duties at Fort Taylor, Key West, and in preparing plans for fortifications at Galveston and the Golden Gate, under the direction of the acting chief engineer. Lieutenant Hunt supposes that he may next spring find time to continue this useful work, and that his labors will not be superseded by the extensive plan which, upon the suggestion of Professor Henry, the British Association for the Promotion of Science have induced the Royal Society to undertake.

EXPERIMENTAL INQUIRIES.

The progress of the application of photography to the reduction of maps and charts has been much impeded during the past year by the ill health of Mr. George Mathiot, and by the imperfect accommodations afforded by the office. Progress has, however, been made, and the increased facilities recently afforded will now accelerate it. There is no longer any doubt of the complete applicability of photography to preparing reduced drawings, but the art is yet but imperfectly developed.

The experimental inquiries of Mr. J. M. Batchelder during the past year have been the following: 1. On the use of a surface of iridium deposited on copper plates in the battery, which it is thought facilitates the wiping of the plate, though protecting the surface imperfectly against wear. 2. On the application of Lieutenant E. B. Hunt's sounding apparatus and tide-metre, the trials of both of which have been successful. 3. On the contraction of distilled water by pressure in reference to its use in Saxton's sounding apparatus, and on the relative contraction of vulcanized India rubber and water, which proved to be in the proportion of 60 to 62 at 49° Fahrenheit, and under a presure of a hundred atmospheres. 4. On the comparative contraction of charts printed on ordinary chart paper, on thin paper with a cloth backing, and on calendered paper, (*in four directions.*) The *proportions* of shrinkage in length after one month of ordinary drying was as 83, 55, and 29, the chart paper contracting from 36 inches in length to 35.1. 5. On the volume of distilled water and of sea water at low temperatures, the former from 21° centigrade to —2°.6, and the latter from 16° centigrade to —2°.9. 6. On the relative contraction by moisture of drawing paper coated with a solution of India rubber, and of "parchment paper," with reference to uses for field maps. The expansion of the first named is but half that of the same paper not coated, and the latter had a greater expansion than the paper from which it was made. 7. On the process of photo-lithography, in which a drawing made upon tracing paper with an ink composed of India ink and gamboge is printed by transmitted sunlight upon the stone. 8. Mr. Batchelder has also prepared ice charts, showing the boundaries of the ice in different years in the harbor of Gloucester, Salem, Marblehead, and New Haven. 9. He has also procured the manufacture of braided sounding line of hemp, saturated with India rubber, and has attended to the following matters: electrotypes from waxed paper; the manufacture of paper, lithotype (letter-press;) wire netting in fusible metal for backing thin copper plates; tanned paper; chronograph record by heated wire; Saxton's pressure apparatus, effect of temperature on, and rate of cooling when encased in wood; and on the effect of inclination on the compensating base apparatus.

The report of Mr. Batchelder on Lieutenant Hunt's sounding apparatus and tide-metre is given in Appendix No. 38.

INSTRUMENTS AND APPARATUS.

A very ingenious instrument, the preliminary trials of which have resulted very favorably for harbor soundings and for deep-sea and outer coast tides, has been invented by Lieutenant E. B. Hunt, of the Corps of Engineers, and constructed for the use of the survey. It measures the depth from the surface to the bottom by the pressure of the column of water upon an elastic bag containing atmospheric air, the pressure being communicated through a column of air contained in a flexible tube to a gauge (Ashcroft's) suitably placed. The general principles of the instrument were stated in my report of last year.

For harbor sounding the bag is dragged over the bottom, and the changes of pressure registered on the gauge placed in a boat. For tidal observations, the elastic bag is confined to one spot, and the flexible tube is placed in a boat or vessel or on the shore. The experiments with the apparatus by Mr. J. M. Batchelder have been quite satisfactory. His report, giving a description of the instrument, will be found in Appendix No. 38.

A water level, very simple in construction and applicable in some cases where the use of the spirit level is difficult, has also been invented by Lieutenant Hunt.

AIDS TO NAVIGATION.

Light-house site.—Commander Alden has reported in favor of the erection of a light-house at Red Bluff or Partridge Point, for the entrance to Admiralty Inlet, Washington Territory, and his reasons for the recommendation are given in Appendix No. 45.

Beacons, buoys, &c.—A small light and fog-bell are recommended for Halfway Rock, Casco bay, by Lieut. Comg. Temple, whose report, a copy of which was transmitted for consideration to the Light-House Board, is given in Appendix No. 47. That officer also recommends a buoy for the sands pit formed at the southern end of Sunken Ledge since the survey of Boston harbor, (Appendix No. 11;) and marks for the Luddington Rocks and a shoal near them, in the vicinity of New Haven light-house, (Appendix No. 12.) Lieut. Comg. Murray suggests (Appendix No. 10) the placing of a buoy to mark a dangerous rock, the position of which he determined off Portsmouth harbor, N. H.

Attention has been called to the necessity for a beacon at the "Elbow," Florida reef, in letters from Captain Gray and Lieut. Comg. Temple, and the correspondence in relation to it is given in Appendix No. 48.

The recommendations of Lieut. Comg. Duer for a light-house on Southwest Cape and one on Dog Island, and for buoys to mark the new channel developed by him leading into St. George's Sound, (Apalachicola, Fla.,) are contained in Appendix No. 16. His suggestions also for a permanent beacon to facilitate the entering of the West Pass into the Sound, and for buoys to mark a practicable channel between St. George's and St. Vincent's islands, will also be found in the Appendix, Nos. 17 and 49.

Recommendations made by Lieut. Comg. Richard M. Cuyler, for spar buoys to facilitate the navigation of the southern part of San Francisco bay, are given in Appendix No. 50.

Copies of all these communications have been forwarded through the department to the Light-House Board, for its consideration.

OFFICERS OF THE ARMY.

During the past year Captain J. H. Simpson, U. S. Topographical Engineers, and First Lieutenants J. C. Clark and Andrew W. Evans, have been detached from the work; and Captain T. J. Cram, U. S. Topographical Engineers, and First Lieutenants William Myers and William R. Terrill, have been ordered to the work. Lieutenant E. B. Hunt, of the Corps of Engineers, though not formally detached from the work, has been on duty nearly the whole year with his corps. Captain Simpson, though but a short time attached to the survey, had rendered effective service in deciding the question of a triangulation across the head of Florida peninsula. Lieutenant Clark rendered good service in the office and in the field, and Lieutenant Evans had acquired a large experience in triangulation, which, joined to a natural aptitude for scientific work and great perseverance, made him a most useful assistant.

Captain Cram has before done good service in the survey and has much experience in triangulation.

The number of officers now attached to the survey is twelve, (Appendix No. 3,) being one more than at the date of my last report. Of these, one is in charge and another general assistant in the office at Washington; three are in charge of divisions of the office, and six are on field service, in charge or in training to take charge of parties.

OFFICERS OF THE NAVY.

The exigencies of the naval service have caused the withdrawal of a very large proportion of the sea officers and all the naval engineers from the survey. The first have been replaced, under the law, by the rating of master's mates authorized by the Navy Department, thus preserving the naval form of organization in the hydrographic parties.

On the 1st of September, 1857, (see list in Appendix Nos. 3 *bis* and 4 *bis*, report of 1857,) there were forty-four sea officers, namely: three commanders, thirty-five lieutenants, two acting masters, four assistant and passed assistant surgeons, and five assistant engineers, attached to the Survey. The number on the 1st of September, 1858, see Appendix No. 5, was twenty-four sea officers, and one assistant engineer yet remains on duty on the Western Coast. Twenty master's mates were temporarily attached to the hydrographic parties afloat.

The Survey has lost during the year over which this report extends the services of four experienced and able hydrographic chiefs: Commander B. F. Sands and Lieutenants C. R. P. Rodgers, O. H. Berryman, and J. N. Maffitt, each remarkable in his special province for ability and success. I have elsewhere more particularly noticed their labors in connection with their results. Lieutenant Berryman was detached at the opening of the surveying year.

By a regulation of the Treasury Department the places of the naval engineers are now supplied, one engineer remaining attached to each steamer, when not in active service, to take care of the machinery.

The withdrawal of the naval engineers has required the insertion in the estimates of an item for pay and subsistence of engineers, which was formerly included in the naval estimates.

OBITUARIES.

While engaged in the laborious duty between Cape Henry and Currituck sound, Assistant J. J. S. Hassler was seized by incurable disease, and, after much suffering, died on the 23d of June, 1858. Mr. Hassler was the son of the first Superintendent of the work, to whom, more than to any other man, the credit of its organization is due, and whose energy, peculiar abilities and knowledge, nursed it into life. He was from his youth, under his father's direction, employed in the work; and his restless activity of disposition kept him almost constantly in the field, abridging those periods of relief and relaxation which others seek, and exposing him to attacks of disease under circumstances most unfavorable to resistance. His system seemed to give way suddenly under a complication of disorders, and death found him almost in the midst of his occupations, with a spirit resembling his father's, faithful, devoted, unwilling to relinquish the performance of duty to the very last. Mr. Hassler's age, at the time of his death, was fifty-nine years.

Joseph Whyte, assistant clerk in my office, and who was distinguished for the steady discharge of duty, and for his many amiable and excellent qualities, fell a victim to consumption, in the twentieth year of his age.

A detailed account of the work in the field and afloat will be found in the following chapters, each geographical section occupying one chapter. A general introduction to each chapter gives a summary of the work executed, which is divided into astronomical and magnetic operations; triangulation—primary, secondary, and tertiary; topography and hydrography.

The part taken by each officer in the operations is given, and the statistics of the work from his report.

SECTION I.

FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF THE STATES OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND.—(*Sketch A, Nos.* 1 *and* 2.)

Ten parties have been engaged in this section during the season, namely: three in triangulation and astronomical and magnetic observations; four in topography, and three in hydrography. Their work will be referred to under the following heads:

1. Primary triangulation eastward from the Epping Base, Me., and astronomical and magnetic observations.
2. Secondary triangulation of the entrance of Penobscot bay, Me.
3. Secondary triangulation of Boothbay harbor, and Damariscotta river, Me.
4. Topography of the shores of Sheepscot river, Me., from the entrance to Wiscasset.
5. Topography of Kennebec river completed.
6. Topography of the City of Portland and vicinity of Cape Elizabeth, Me.
7. Topography completed between Scituate and Plymouth, Mass.
8. Hydrography of Sheepscot river, from its entrance to Wiscasset, Me.
9. Hydrography of Kennebec river extended above Bath.
10. Hydrography of the entrance to Casco bay, Me.
11. In-shore soundings complete between Kennebunkport, Me., and the Isle of Shoals, including the entrance to Portsmouth harbor, N. H.
12. Re-examinations in Salem, Lynn, and Boston harbors.
13. Tidal observations in Boston harbor.

It will be observed that the primary triangulation is nearly advanced to the northeastern boundary. The development of a rock off Portsmouth, N. H., by Lieut. Comg. Alexander Murray, United States navy, is of importance; as also that of the bank off Cape Ann. Arrangements have been made to connect the two continents for longitude, as required by law, whenever the telegraph line is in proper working condition and its use can be obtained. With more means to bestow upon this section we could have with economy made more progress, as the number of parties engaged in the southern work during the autumn, winter and spring makes quite a considerable force disposable for the season in which work is most profitable in this section. This economy, upon which I have often insisted, is lost by diminishing the scale of the appropriation. The exigencies of the government having been decided as requiring it, I have cheerfully submitted to a reduction, but it is nevertheless my duty to point out the consequences, so that the responsibility may not rest upon me.

I have to regret the loss of the services of Lieut. Comg. C. R. P. Rodgers, U. S. N., whose zeal, industry, knowledge, and experience were of the highest value to the survey. In command of the steamer Bibb he completed the difficult hydrography of the Nantucket Shoals and the off-shore work of the coast of Massachusetts. His indefatigable industry also found time for hydrography on the coast of North Carolina, (Section IV,) near Cape Lookout.

Office-work.—A map of Rockport harbor, scale $\frac{1}{10000}$, and a sketch showing Epping Plains base, $\frac{1}{20000}$, have been drawn during the year. The following maps and charts have been in progress: Finished chart No. 9, of the coast of New Hampshire and Massachusetts, from Portsmouth to Cape Ann, $\frac{1}{80000}$; No. 10, from Cape Ann to Scituate, $\frac{1}{80000}$; No. 11, from Scituate to Nausett, $\frac{1}{80000}$; preliminary chart No. 3, from Cape Neddick to Scituate harbor, $\frac{1}{200000}$; and general coast chart No. II, from Cape Ann to Point Judith, $\frac{1}{400000}$.

The engraving has been completed during the year of preliminary chart No. 4, $\frac{1}{200000}$, from Plymouth, Mass., to Saughkonnot river, R. I.; Annissquam and Ipswich harbors; Wood's Hole harbor, and Bass River harbor. Considerable progress has been made on the plates of preliminary chart No. 3, $\frac{1}{200000}$, from Portland to Race Point, Mass.; coast chart No. 12, $\frac{1}{80000}$, from Monomoy Point to Muskeget Island, and coast chart No. 13, $\frac{1}{80000}$, from Muskeget Island to New Bedford, Mass. The chart of Kennebec river and a sketch of Epping Base have been engraved upon stone, under the direction of the Superintendent of Public Printing.

Primary triangulation on the coast of Maine.—The party under my immediate direction was organized for commencing work in this section in the latter part of June. Humpback Mountain, in the township of Brewster, Hancock county, Me., was occupied for continuing the primary triangulation towards the northeastern boundary. The occupation of only two more stations is now necessary to complete it to that line. Preliminary arrangements at the station were satisfactorily made by Mr. Thomas McDonnell early in July, but the prevalence of dense fogs and stormy weather prevented the commencement of the observations until the 19th of that month. Fftcen points were observed upon with the thirty-inch theodolite, C. S. No. 1, viz.: six primary and eight secondary signals, and the elongation mark which was established for the determination of azimuth. Sketch No. 1 represents the relative positions of all the points. The most distant signal was that on Ragged Mountain, which, in a direct line, is about sixty-eight miles from the station on Humpback. Five of the signals were at distances ranging from thirty to fifty-three miles. In the measurement of horizontal angles twelve hundred observations were made and recorded. Vertical angles were measured on nine stations by three hundred and fifty observations with the eight-inch Gambey circle, C. S. No. 57, in connection with a hundred and fifty measurements with the Ramsden micrometer of the thirty-inch theodolite. The geodetic observations were principally made by Assistant George W. Dean; Lieutenant Thomas Wilson, U. S. A., on Coast Survey service, assisted in the operations. Estimated in the usual manner, the area embraced within the limits of the primary triangulation is about eight hundred and fifty square miles. I was indebted to Assistant C. O. Boutelle for posting the heliotropers at the commencement of the season, and to Assistant Dean for his able charge of the party during my absence on other duty.

Astronomical observations.—The azimuth of the lines connecting Humpback station with others in the primary triangulation was determined with the thirty-inch theodolite, from ten sets of observations on Polaris, when near its eastern elongation, and five sets on δ Ursæ Minoris, near its upper culmination. These observations were referred in the usual manner to an elongation mark fixed at a distance of about two miles from the station. Each set consisted of five pointings on the star, with the telescope direct, and the same number with it reversed, in connection with twelve sets of observations on the mark, the telescope being as before direct and reversed. All the observations were made by Mr. Dean, assisted by Lieutenant Wilson, who also made a complete reduction of the work when the observations were finished. For latitude and time the observations were made by Mr. A. T. Mosman and Lieutenant Wilson, aided by Messrs. A. W. Thompson and Henry W. Bache. The zenith telescope, C. S. No. 5, was used for the purpose, and two hundred and ninety-five sets were recorded of observations on thirty-seven pairs of stars. The value of one revolution of the micrometer was ascertained by two hundred and forty-three observations of the circumpolar stars Polaris and 51 Cephei, when near their eastern elongation, and seventy-nine observations with the micrometer were made upon a collimator, adjusted to a sidereal focus, in determining the value of the level-scale graduation.

In addition to the observations just mentioned, ninety-five sets were made by Lieutenant Wilson on fifteen pairs of stars for latitude. The time requisite for the azimuth and latitude observations was determined by the same observers from two hundred transits of zenith and circumpolar stars, which were observed with the Würdemann (portable) transit, C. S. No. 10. The reduction of the latitude observations, with the discussion of probable errors, was completed by Mr. Mosman, and duplicate copies of the latitude and time records were made by Mr. H. W. Bache before leaving the station.

Magnetic observations.—These were made by Assistant Dean, aided by Messrs. Mosman and Thompson, near the geodetic station on the summit of Humpback mountain. The declination was determined by one hundred and forty-four observations on three days; and the horizontal intensity and moment of inertia from two sets of experiments on different days. The dip was ascertained at two points on the summit ridge of the mountain, but the difference in the results obtained did not much exceed the usual accidental errors of such observations. Four sets were made on three days for that element. The instruments used were the declinometer D. 22 (C. S. No. 1) and the ten-inch dip circle C. S. No. 4.

Meteorological observations.—The usual journals were incidentally kept during the progress of operations at Humpback station, by Mr. Richard E. Evans, one of the aids in my party. At the geodetic station three hundred and twenty readings of the mountain barometer (Green No. 911) and a hundred and fifty of the Dent (Aneroid) No. 8580, were recorded. Three hundred and ten observations of the temperature, and two hundred and seventy-five readings of the psychrometer were also entered, with remarks in regard to the prevailing winds and other conditions of the atmosphere in the vicinity of the station. On the eastern slope of the mountain, at the camp which was distant about an eighth of a mile from the summit, a hundred and ninety-eight readings of the aneroid barometer, and an equal number of observations for temperature, were recorded. Before leaving the station Mr. Evans completed a duplicate of the original geodetic records. Since that period twenty-one volumes containing originals and duplicates of the records of horizontal angles, observations for time, latitude, and azimuth, have been deposited in the office with the field computations and duplicates of the notes of magnetic observations. The recorded observations for latitude made in 1857 at Calais, Maine, have been duplicated by Assistant Dean, and turned in with the originals and duplicates of the journals of magnetic observations made in the same year at Calais and at Bangor. Sub-assistant Edward Goodfellow has completed and sent with the original a duplicate of the journal of the Epping base measurement, together with a record of the comparisons made during the progress of that work, illustrative diagrams, and a register of the meteorological observations. Later in the season he completed a duplicate of the volume containing the record of latitude observations made at Bangor in 1857. This and the original have been placed in the office with Mr. Goodfellow's computations of the latitude, and a record of the places of the stars used in the observations at Thomas' Hill station. Records of the measurement of the vertical angles observed at the ends of Epping base and at Thomas' Hill, Maine, have been received in duplicate from Assistant C. O. Boutelle.

Triangulation of Penobscot bay, Maine.—Preparations for commencing the secondary triangulation on this part of the coast of Maine were made in the latter part of July. A reconnaissance for the selection of stations was then executed by Assistant C. O. Boutelle, who was assisted in that duty by Sub-assistant Stephen Harris, to whom had been also assigned the measurement of the angles. The schooner Wave, with the party of Mr. Harris, arrived at the site of work on the 5th of August. As laid out, and in part executed, the secondary work rests upon the line joining the primary station on Ragged mountain, a few miles west of Camden, with the primary station on Isle au Haut, the length of which has been determined by the main triangulation. Below this line, the stations selected, and some of which were observed on (Sketch No. 2,) include the Fox islands, the Matinicus group at the entrance of Penobscot bay, Metinic island, Green island, the Muscle Ridge group and the western shore of the bay, the stations there being situated on the ridge dividing it from St. George's river. The latter part of the season was employed in the measurement of horizontal angles. Prevailing fogs hindered the observations very much, especially those depending on the signals erected in the lower part of the bay. On the main land fires in the woods also interfered with the lines of sight. The twelve-inch Gambey theodolite, C. S. No. 37, was used in the angular measurements. Sub-Assistant Harris thus reports the statistics of the triangulation:

Signals erected	22
Angles measured	58
Number of observations	2,318

The operations were closed on the 29th of September.

Triangulation of Boothbay harbor and Damariscotta river, Maine.—The secondary triangulation of the Kennebec river and its dependencies has been continued eastward by the party heretofore employed in that work. In the latter part of July Sub-assistant F. P. Webber erected a large tripod and scaffold near Boothbay harbor, and then proceeded to Wiscasset and made in that vicinity a general reconnaissance for extending the triangulation along the Damariscotta river and around the shores of John's bay. A number of stations (Sketch No. 2) were chosen, and signals erected for observing with the theodolite. Four of these were occupied. From the 9th of August the operations of the party were in charge of Sub-assistant B. Huger, jr., in conjunction with Mr. Webber, and so continued until the middle of September, when the work was closed for the season. The limit reached, going eastward, is the western side of Muscongus bay.

Mr. Julius Kincheloe served in the party as aid. A summary of statistics is thus given by Mr. Huger:

Angles measured	50
Objects observed on	42
Number of observations	561

An area of about sixty square miles was furnished with points for the topographical party. Estimated in the usual way the triangulation covers an area of a hundred and fifty square miles. The first part of the surveying season was employed by Sub-assistant Webber in Section V, reference to which will be made elsewhere. Sub-assistant Huger was then engaged in similar duty in Section VI. The schooner Hassler was used by the party working in the vicinity of Wiscasset. At the usual period for resuming work at the south, the vessel was transferred, and will be employed in continuing the triangulation of the coast of Georgia. The volume containing entries of the horizontal and vertical angles measured in the triangulation of Sheepscot river in 1857, was duplicated by Lieutenant A. W. Evans previous to his detachment from the survey, and is now on file with other field records.

Topography of Sheepscot river, Maine.—In August, Assistant I. Hull Adams took up plane table work in this vicinity, and before the close of the surveying year traced both shores of the Sheepscot from Hendrick's Head Light upwards to the town of Wiscasset. The shore lines of the entrances of Back river connecting the Sheepscot with the Kennebec, and those of the entrance of Cross river passing the Edgecombe quarries a few miles below Wiscasset were also traced, and the river-side of the islands above the mouth of the Sheepscot. At Edgecombe (Sketch No. 2) a minute topographical survey was made of the quarries, the surface being contoured on the sheet so as to represent the natural features of that locality. The shore-line of the river, as needed by the hydrographic party, was furnished by Assistant Adams. On both the amount of shore-line represented is about forty-nine and a half miles. The area of the part minutely surveyed is somewhat less than two square miles. Other topographical duty performed by Assistant Adams will be referred to in Section III, whence he is about making arrangements to return. Mr. James G. Macawley has been attached to this party as aid.

Topography of Kennebec river, Maine.—In order to furnish the details necessary for a finished map of this river, Sub-assistant W. S. Gilbert resumed duty near Heel's Eddy on the 2d of August, and traced in the additional features required on his sheet of last season, until the middle of September, when Assistant R. M. Bache took charge of the party. "The survey was then commenced in the vicinity of Bath, the water line of the wharves completed, and the shore-line of both sides of the Kennebec upwards (Sketch No. 2) so as to include Merry Meeting bay, about two miles above the city proper. The work was also carried back to the furthest main roads on both sides, which were continuous in a direction somewhat parallel to the river." At this date Assistant Bache is at work opposite the city of Bath, and intends to remain in the field until the details of that vicinity are inserted on the plane table sheet. The topography will then be essentially complete from the entrance upward, and including Merry Meeting bay, excepting the running in of the streets, &c., of the city of Bath. Sketch No. 2 is an engraved reduction from the work done within the present season. The following are the statistics :

Shore and wharf lines	25½	miles.
Roads	27½	"
Area in square miles	15½	

Sub-assistant Gilbert is now making arrangements to return to Section VIII. His work of the early part of the year will be mentioned in the chapter referring to that Section.

Topography of Portland harbor, Me.—The party of Assistant A. W. Longfellow resumed work in the vicinity of the city of Portland on the 8th of July, and made steady progress in contouring the ground and filling in the details of the map of Portland harbor and its environs, which is now entirely completed.

"The contouring has been executed with great care, and the heights of the stations, as the eye cannot be trusted in such measurements where the scale and locality vary, were deduced from established elevations ascertained by the triangulation party. The contours on Cape Elizabeth, and the islands on the east side of the harbor, were found to be quite intricate and difficult of access and determination on account of the wooded character of those localities."

The most recent developments in the city of Portland, including numerous changes and additions, were sketched in by Assistant Longfellow, and the topography of that immediate vicinity, in all essential particulars of detail, brought up to represent the actual surface features at this date. Assistant A. S. Wadsworth and Mr. C. H. Boyd were attached to this topographical party.

At the end of the season, the schooner Meredith, which had been used for transportation, proceeded to Section V. Assistant Longfellow is now engaged in inking several finished sheets of his former work in Casco bay, and the sheet of Portland harbor, which is just completed. Assistant Wadsworth has been instructed to resume field duty in Section IV.

Topography between Scituate and Plymouth harbor, Mass.—Assistant A. M. Harrison, having last season finished the plane table survey of the shores of Plymouth harbor, took the field immediately after his return from duty in Section V, and on the 12th of July resumed work near Green Harbor river. The sheet projected for the present season (Sketch No. 2) now contains the details of the shores of North river, several tributary streams, and the western shore of Massachusetts bay from the mouth of that river northward to the limits of former work near Scituate.

"The general character of the country surveyed does not differ materially from that of the shore of the State elsewhere, the topographical details, as represented on the sheet, embracing marsh, creek, hills, forest, cultivated fields, &c." The ordinary statistics are thus stated by Mr. Harrison:

Shore-line, (outside)	5.75	miles.
River shore-line	16.25	"
Creeks	13.50	"
Roads	13.50	"
Marsh line	19.00	"
Area in square miles	7.75	

Sub-Assistant W. H. Dennis was attached to the party, and used the plane-table constantly until the close of the season at the end of September. The surveying schooner Peirce, which was employed for transportation, had previously been in the service of this party in Section V. Under that head other plane-table work, executed by Assistant Harrison, will be described.

Hydrography of Sheepscot river, Me.—This river has been thoroughly sounded from the entrance upward, a distance of rather more than thirteen miles, to Wiscasset, (Sketch No. 2,) by the party of Lieut. Comg. J. H. Moore, U. S. N., assistant Coast Survey, in the surveying schooner Varina. Eleven miles of the shore-line were determined for preliminary purposes by the draughtsman of the hydrographic party.

In reference to the character of the Sheepscot, Lieut. Comg. Moore observes: "There is an excellent channel in this river, giving from thirty-seven to sixteen fathoms water. The depth gradually decreases in going up the channel, unobstructed by ledges; has no less than sixteen fathoms. The current runs straight up and down the river. Cross river, at Edgecombe quarries, affords an excellent anchorage in ten fathoms, sticky bottom." Two tidal stations were occupied in the hydrographic work on the Sheepscot. The following are the general statistics :

Miles run in sounding	393
Stations occupied with the theodolite	25
Angles determined	1,781
Number of soundings	13,462

Assistant I. Hull Adams supplied tracings from his plane-table sheets of the river for the use of the hydrographic party. The soundings were commenced in July and closed at the end of September, when the party resumed work in Section II, as will be mentioned further on.

Hydrography of Kennebec river, Me.—Before taking up the work just noticed, Lieut. Comg. Moore continued the soundings in Kennebec river northward from Bath, extending the hydrography in that direction about two miles and a half from the limits of the sheet of Lieut. Comg. Trenchard, made in 1857, and including the stretch called Merry Meeting bay. The shore-line necessary was furnished by the topographical party jointly in charge of Assistant R. M. Bache and Sub-Assistant W. S. Gilbert. The tides were observed at two stations while the soundings were in progress. A summary of the details of work is thus given in the report of Lieut. Comg. Moore :

Miles run in sounding	56
Angles determined with the theodolite	907
Casts made with the lead	5,760

A reduction from the upper sheet of the Kennebec will be seen in Sketch No. 2.

Hydrography of Casco bay, Me.—Soundings necessary to complete the hydrography of the entrance to Casco bay have been made by Lieut. Comg. W. G. Temple, U. S. N., assistant in the Coast Survey, with a party in the steamer Corwin. The sheet, when plotted, will join with one executed last year to include the vicinity northward and westward from Cape Small Point. Halfway Rock lies in the middle of the space sounded, and its western limit joins at Green island with work completed in 1853. The entire entrance (Sketch No. 2) between Bald Head and the Portland light has now been sounded out, and the work connected with the hydrography of Portland harbor and that of the western half of Casco bay. Lieut. Comg. Temple commenced this duty on the 27th of August and closed operations on the 15th of September, taking other special work on his return southward. The following are the statistics :

Angles determined	718
Miles run in sounding	227
Number of soundings	2,054

A hydrographic sheet of the work executed in Casco bay by the party of Lieut. Comg. Stephen D. Trenchard was plotted and turned in soon after the detachment of that officer.

The subsequent office-work of his party, consisting of the middle sheet of the chart of Kennebec river, a second sheet of the soundings in Casco bay, and two others, showing the soundings made late in 1857 to determine the character of Jordan's Rock and the depth on a bank in the inner harbor of Portland, was completed under the direction of Lieut. F. A. Roe. These were accompanied by the original records of soundings and angles observed in the hydrography of the Kennebec river, a duplicate of the tidal register kept there, the original journals of soundings, angles, and tides observed in Casco bay, and similar records of the work executed by the party in 1856 at Annis Squam and Ipswich, Mass.

In-shore hydrography abreast and northward of Portsmouth harbor, N. H.—At the end of July, Lieut. Comg. Alexander Murray, U. S. N., Assistant in the Coast Survey, with a party in the steamer Bibb, joined the limits of hydrography completed last year near the isles of shoals, and extended in-shore soundings in a direction northward and eastward to Kennebunkport, (Cape Porpoise,) Me. The approaches to Portsmouth harbor, N. H., are included on the hydrographic sheet which represents (Sketch No. 2) a stretch of twenty-one nautical miles along the coast, and a breadth of ten, the soundings being carried out to sixty fathoms water.

Lieut. Comg. Murray has sent to the office the chart of this work, from a note on which the following abstract of statistics has been taken :

Miles run in sounding	969
Angles determined	2,957
Number of soundings	9,033

In reference to the character of the hydrography he remarks : "Some of the work may appear unnecessarily close, but the broken nature of the bottom, and the near neighborhood of a considerable harbor, as well as the results obtained while it was in progress, justified, in my opinion, the most searching scrutiny." While prosecuting the soundings outside of Portsmouth harbor, Lieut. Comg. Murray was informed of the existence of a rock the position of which had not been marked on any chart. He proceeded at once to the vicinity and determined the bearings necessary for finding or avoiding it in making the entrance.

These results were transmitted to the department in my communication of September 10, from which the following is an extract :

"The monument on York ledge bears N. 29° 15′ E., distant 1$\frac{3}{4}$ nautical mile.

"The light on Whale's Back bears S. 78° W., distant 4 nautical miles.

"Boon island is 6$\frac{1}{2}$ nautical miles distant, and with Whale's Back on range, will nearly include the rock, it being 6° 30′ to the southward."

The sailing directions for clearing the rock are contained in the same communication, Appendix No. 10. A rock was also found one-third of a mile to the eastward of that just described, with twelve feet water at mean low tide. Other developments made by the party in the course of the season, of prominent features of the ocean bottom in this part of the section, may be enumerated as follows :

"A detached rock two-thirds of a mile northward and eastward of York ledge.

"Duck Island ledge.

"Boon Island ledge.

"Fishing ledge, off Kennebunk, Me.

"A rock off York River, Me., bare at low tides and dangerous to coasters. It is more than a mile from the shore.

"A rock, one mile to the southward and westward of Boon island, with seventeen feet water. The sea breaks on it in heavy weather."

In addition to those mentioned above, the position of a rock off Cape Neddick was determined and plotted on the chart.

Re-examination of Lynn harbor, Mass.—As incidental to the work of the season, Lieut. Comg. Murray ran several lines of soundings to verify the hydrography of Lynn harbor, the survey of which was made in 1853–'54. The plotting of the recent soundings is now in progress. It is remarked, as preliminary to a final comparison with the older chart, that no material differences have been discovered. The following is a synopsis of the statistics:

Miles run in sounding	$32\frac{1}{2}$
Angles determined	202
Number of soundings	2,916

Off-shore soundings.—In passing to the site of the work last referred to, in the steamer Bibb, Lieut. Comg. Murray started a line of soundings eastward of Monomoy light, and carried it northward nearly to the latitude of Cape Ann, where it was interrupted by bad weather. An additional line was also put in outside of the completed in-shore soundings of last season below Portsmouth. With regard to other off-shore work executed by the party at a later period of the season, Lieut. Comg. Murray reports as follows:

"The deep-sea soundings to the northward and eastward of Cape Ann develop a bank, mention of which is made as shoal ground, on a chart by Mr. Eldridge, of Chatham. We have gone far towards ascertaining its limits and general character, and will be enabled to make it useful in directing the approach of mariners in thick weather, or by night, upon that part of our coast." Sketch No. 2 shows the number and direction of the lines run. A summary of statistics is given below as taken from the off-shore chart.

Miles run	370
Casts of the lead	484

The hydrographic party in the steamer Bibb spent the early part of the surveying year in Section IV, and under that head its previous labors will be mentioned. While there, Lieut. Comg. Murray succeeded to the command on the detachment of Lieut. Comg. C. R. P. Rodgers, U. S. N., from Coast Survey duty. Previous to his withdrawal, the last named officer completed, under his immediate direction, the office-work of his chart of off-shore soundings between Newburyport and Monomoy; another showing the hydrography between Annis Squam and Thatcher's island, (Cape Ann;) a third, of the soundings made by his party near Naushon, Mass.; and a fourth, containing the supplementary hydrography executed by him in the vicinity of Cuttyhunk and Gay Head. These have been registered and placed in the office. The original records of soundings and angles observed in the work off Cape Ann and Ipswich in 1857 have also been received and filed with similar data. Early in October the steamer Bibb returned to New York, where she is now undergoing necessary repairs. Lieut. Comg. Murray then took up his office-work, and has completed charts of all the hydrography executed by his party.

Examination of the positions and character of buoys of Salem harbor, Mass.—The chart of this harbor, which was issued from the office in 1855, having been made the subject of criticism, in August last, Lieut. Comg. Temple incidentally examined the alleged deficiencies, on his return from Casco bay, with the following results:

A buoy northwest of the Haste, another on the spit south from Satan, and a third northeast of Coney island, stated to be not in the harbor, were found in place, as marked on the chart.

It has been ascertained, by inquiry at the Light-house Board, that buoys were placed on the eastern side of Coney Island ledge and on the Triangles since its publication. At variance with the assertion that "the channel is to be westward" [of the Triangles,] Lieut. Comg. Temple says "the fact is as represented on the published chart."

An error represented by Lieut. Comg. Temple as "of but little practical importance" was detected in the notes relative to the Little Haste Rock, which is bare at two-thirds ebb. The rock, however, is very small, and marked by a pole, as stated in the engraved notes. The spar on Little Aqua Vitae, designated as being black, was found of the natural color of wood, after being long exposed to the weather, and Abbott's Rock beacon "topped with a square slatted cage or box," instead of a cask, as described on the chart of 1855. The only error of any consequence noticed on the chart by Lieut. Comg. Temple was the mark of a beacon near the end of the bar on the Beverly side of the channel. This has since been expunged from the plate. The hydrography of Salem harbor was executed in 1850–'51, by Lieut. Comg. C. H. McBlair, and the result of the comparison, which was made at the end of September last, fully sustains the character of the original survey in all essential particulars. In that revision work seventeen miles were run in sounding, a hundred and seventy angles determined, and nine hundred and twenty-four casts made with the lead.

Hydrographic examination in Boston harbor.—On his way northward, in the steamer Corwin, Lieut. Comg. Temple made an examination of Shirley's Gut, leading between Deer island and Point Shirley, and forwarded a chart of that locality to the office. In returning southward from Casco bay supplementary soundings were made in the vicinity of Sunken Ledge, a spit of sand and gravel having made out from it since the date of the survey of Boston harbor, so as to require a corresponding alteration in the chart. A close examination was also made of the channel leading around Hough's Neck and Sailor's Snug harbor, to determine the position of a rock on which one of the pilot's boats was alleged to have struck. No rock in that vicinity, not marked on the published chart, could be found. As the accident happened in thick weather, and the position of the boat was not ascertained by bearings on the land, the conclusion reached by Lieut. Comg. Temple was that she struck on one of the rocks now laid down on the chart. A similar examination was made with like result in the neighborhood of Tower Rock. In those just referred to, and other localities of Boston harbor visited incidentally for purposes of revision, the following aggregate of work was done by the party in the Corwin:

Angles determined	332
Miles run in sounding	26
Number of soundings	1,512

In reporting upon the result of his examination of Sunken Ledge, Lieut. Comg. Temple recommended the placing of a buoy at the extremity of the sand pit south of the beacon, the subject of which was communicated to the department, in October, for the information of the Light-house Board.—(Appendix No. 11.)

The hydrographic vessel is now refitting at New York for a return to the Florida reef. A recommendation of Lieut. Comg. Temple, for the establishment of a small light and fog-bell on Halfway Rock, was communicated to the department in September.—(Appendix No. 47.)

Tidal observations.—The series of observations at the Charlestown navy yard, Mass., has continued unbroken. It now extends over a period of eleven years, during which only about half a dozen observations have been lost.

SECTION II.

FROM POINT JUDITH TO CAPE HENLOPEN, INCLUDING THE COAST OF CONNECTICUT, NEW YORK, NEW JERSEY, PENNSYLVANIA, AND PART OF DELAWARE.—(SKETCH B, No. 7.)

The usual parties have been at work in this section, and an additional one has been employed in observations for longitude, viz:

1. For determining by telegraph the difference of longitude between Albany and New York city. Observations were also made for latitude and the magnetic elements in New York city, and for the magnetic elements at Albany.

2. Triangulation of Hudson river from Tunnel Point northward to the city of Hudson: points determined for the sounding of Rondout and Esopus creeks, and plane-table surveys made of their shores.

3. Topography of the north shore of Long Island, from Little Neck bay westward to Hunter's Point.

4. Topography of the shores of Newark bay, and of the western shore of Arthur Kill, from Newark southward to Perth Amboy, N. J.

5. Hydrography of the Hudson extended above Fishkill; and soundings made in that river adjacent to the entrances, and also in the beds of Rondout and Esopus creeks.

6. Observations on the currents of East river, and on those of New York harbor and its approaches.

7. Tidal observations in New York harbor.

In addition to the regular hydrographic operations in this section, the position of a rock in the vicinity of the light-house near New Haven, Conn., was incidentally determined by one of the parties while on its way to Section I.

Office-work.—The following diagrams and sketches have been drawn, viz: Sketch showing the current stations in and near the entrance of New York harbor, and diagrams showing the velocity of the currents; also, sketches showing the set of the currents in Sandy Hook bay.

The finished map (new edition) of New York bay and habor, $\frac{1}{80000}$, has been in progress. In a preliminary form the chart of that harbor has been engraved on stone, under the direction of the Superintendent of the Public Printing.

Astronomical and magnetic observations at Albany and New York city.—In connection with the triangulation of the Hudson river, it was desirable to establish the latitude and longitude of a point at Albany by a careful series of astronomical observations. The execution of this work, under the immediate direction of Dr. B. A. Gould, jr., Assistant, was assigned to the astronomical parties in charge of Assistant George W. Dean and Sub-Assistant Edward Goodfellow, immediately after their return from duty in Section VIII, and the Coast Survey station was placed on Van Rensselaer Hill, near the Dudley Observatory.

At New York, L. M. Rutherford, esq., generously placed his private observatory at our disposal, and personally rendered every facility for the successful prosecution of the operations. The location being one of the most favorable for astronomical observations within the city limits, had been previously occupied by the party in charge of the late Professor S. C. Walker, in determining the telegraphic differences of longitude between Washington, Philadelphia and Cambridge.

The construction of the Coast Survey station at Albany was completed by Mr. Thomas McDonnell, artificer, in the early part of May, and the astronomical instruments, together with the necessary telegraphic apparatus, were adjusted in position at the respective stations as early as practicable after the transfer of the longitude parties from New Orleans to New York.

Upon the application of Dr. Gould the telegraph lines between Albany and New York were promptly placed at the disposal of the Coast Survey, free of charge, after 9 o'clock p. m., by James D. Reid, esq., general superintendent of the New York, Albany and Buffalo telegraph lines. The local superintendent, Mr. C. S. Cutter, of Albany, and Mr. C. Whiting, of New York, also cheerfully contributed all desirable aid in perfecting the telegraphic arrangements.

Unfavorable weather delayed the longitude experiments until the 24th of May, at which time they were commenced, and actively prosecuted to a successful close on the 18th of June. The following statistics are derived from records kept at the respective stations:

At Albany two hundred and ten observations were made for determining the time and instrumental corrections, and forty-seven on circumpolar stars for ascertaining the thread intervals of Transit No. 4. A hundred and sixty stars were observed for longitude by the electro-magnetic method, in connection with the station at New York.

At New York two hundred and twenty-five observations were made for local time and instrumental corrections, and for the thread intervals of Transit No. 6 ten others on circumpolar stars. For the telegraphic difference of longitude the same stars were observed at this as at the Albany station.

The personal equation between Dr. Gould and Mr. Goodfellow was determined by observations made at Albany on twenty-three stars, and that between Mr. Dean and Mr. Goodfellow was determined at New York by observing ninety-three stars on four nights.

The latitude of the station (Rutherford Observatory) was ascertained from eighty-nine observations, which were made upon twenty-four pairs of stars, by Sub-Assistant Goodfellow, with the Coast Survey zenith telescope No. 5. A meteorological journal was kept at that station, and a hundred and fifteen readings of the barometer and thermometer were recorded.

On the completion of the astronomical observations at New York in the latter part of June, Assistant Dean and Mr. A. T. Mosman, aid, joined the astronomical and geodetic party under my own charge in Section I; and the completion of the office-work connected with the observations made at New York was assigned to Sub-Assistant Goodfellow.

Magnetic observations.—The declination and moment of inertia with the horizontal and vertical intensity of the terrestrial magnetism at Albany were determined by Mr. Dean at a station near the Dudley Observatory. For ascertaining the declination, the direction of a suspended magnet was observed every fifteen minutes, from 6 a. m. to 6 p. m., during three consecutive days. The horizontal intensity and moment of inertia were determined by two complete sets of experiments on two days, and the dip of the needles was obtained from four sets of observations, on different days, at three different points within the grounds of the Dudley Observatory.

A duplicate and the original journal of the magnetic observations have been received from Assistant Dean.

Sub-Assistant Goodfellow has sent the original and duplicates of the notes of latitude observations at New York, with his computation derived from them, and a list of the places of the stars observed.

Triangulation of Hudson river.—The party of Assistant Edmund Blunt resumed work on the 20th of April in the vicinity of Rondout, and carried the main and secondary triangulation of the Hudson jointly northward until the close of the season on the 1st of November. The upper limit reached is in the neighborhood of the city of Hudson, a stretch of about twenty-six miles by the river course, being embraced in the triangulation of the present year.

Within a series of main triangles, Assistant Blunt occupied numerous secondary points immediately adjacent to the banks of the river, and has determined the geographical positions of a number of points sufficient for the most elaborate topographical survey that could be desired. In the duties of the field he was assisted by Lieuts. A. H. Seward and W. R. Terrill, U. S. A., on Coast Survey service, and by Sub-Assistant Clarence Fendall.

The scheme of triangles measured, in extending the work on the Hudson, is shown on Sketch No. 7. A synopsis of the statistics reported in detail by Assistant Blunt gives as the result of the field operations:

Stations occupied	96
Observations on primary signals	4,116
Observations on secondary signals	5,822

An area of about eighty-four square miles is included within the triangles.

The officers attached to this party as assistants have been assigned to duty at the south, and their preparations are now well under way for prosecuting triangulation work in Section VI.

Lieut. Seward has sent to the office two volumes containing the records of horizontal angles measured on the Hudson in 1856.

Topography of Rondout and Esopus creeks.—The surveys of these creeks to the head of tide-water having been specially directed by the department, Assistant Edmund Blunt determined the points necessary for the use of the plane-table and hydrographic parties. Under his direction Sub-Assistant Clarence Fendall then traced the shore-lines of both streams, and executed the topography of their banks, and also that of the west bank of the Hudson, in the immediate vicinity of their mouths.

The survey of the Rondout was carried westward about three miles from its entrance, and that of the Esopus nearly two miles.

Supplementary topography of New York harbor.—This work has been pushed in two localities and essentially completed by two parties working under the general direction of Assistant H. L. Whiting. That conducted by himself in person retraced the shore-line of East river, from Little Neck bay, opposite Throg's Neck, westward to Hunter's Point, abreast of the lower end of Blackwell's island. The details within that stretch were divided for execution, and now appear on two sheets which join at Flushing bay. In filling in these Mr. Whiting was aided by Mr. Cleveland Rockwell. All the topographical features of this part of Long Island, as now existing, are represented on the sheets in a well conditioned margin characteristic of the northern shore and interior of the island in that vicinity. The numerous roads giving access in every direction, and the close and generally uniform divisions of the highly cultivated land, as indicated on the map, present a large amount of intricate field work.

A summary of the statistics is thus reported by Assistant Whiting:

Shore-line (two sheets)	$24\frac{1}{4}$ miles.
Marsh-lin	$30\frac{1}{2}$ "
Creeks	$16\frac{1}{2}$ "
Roads	119 "
Railroad	$4\frac{1}{2}$ "
Area, in square miles	$26\frac{1}{4}$

The work here referred to was begun early in July and completed on the 25th of October.

Sub-Assistant H. S. Du Val, who had been assigned to duty in the party of Mr. Whiting, was compelled by ill health to leave the field shortly after reporting for service. He has, however, recently completed arrangements for conducting a topographical party in Section V.

Assistant Whiting is now engaged in inking his plane-table sheets of New York harbor and those of another section in which he was employed during the early part of the surveying year.

Topography of Newark bay, and the western shore of Arthur Kill, N. J.—Under the general direction of Assistant Whiting, Sub-Assistant F. W. Dorr took the field in the middle of July, commencing work on the neck about a mile and a half above Bergen Point. From thence he traced the shore of Newark bay and Hackensack river as far up as the New Jersey railroad, the line of which was made the northern limit of the topography to be executed.

In this vicinity the plane-table work of the season joins with that completed last year by Mr. Whiting. The sheet embracing the upper part of Bergen Neck presents a considerable amount of detailed topography, and contains, in addition to the general surface features, the towns of Bergen, South Bergen, Greenville, and Saltersville.

Passing westward along the line of the railroad already referred to, the plane-table work was continued on a second sheet which joins with the one last described, near the mouth of the Passaic river. In that neighborhood the banks of the river were surveyed as far as the railroad bridge, including the shore-line and wharves of Newark and the greater part of the strip of fast land called Newark Neck. On the south, the sheet is bounded by the marsh-line of the large tract of salt meadow which forms part of the western shore of Newark bay.

A third sheet, projected by Mr. Dorr, takes in the remaining shore of the bay, the entire western shore of Arthur Kill or Staten Island sound, the towns of Elizabethport and Perth Amboy, with the intermediate details and those below the last named city, extending as far south as Sandy Point, on the Raritan river. The surface features throughout are represented in a margin of rather more than a mile in breadth, bounded on one side by the shore-line.

Sub-Assistant Dorr was aided in the field by Mr. James Gilliss. The aggregate statistics of the three topographical sheets are as follows:

Shore-line	$40\frac{1}{4}$ miles.
Marsh-line	$39\frac{1}{2}$ "
Creeks	105 "
Roads	120 "
Railroads and canal	$21\frac{1}{3}$ "
Area, in square miles	$34\frac{1}{2}$

Mr. Dorr was employed in this work until the 17th of November. He then made preparations to return to Section VI, where he had been previously engaged, as will be noticed in a subsequent chapter of this report.

Of last season's work, Assistant Whiting has inked and sent to the office his sheet extending from Jersey City to Gutenberg, and another showing the topography above and below Fort Lee; one of the survey of Staten Island, and the sheet containing Ward's, Randall's, North and South Brother, and Riker's island.

The topographical sheet, extending from High Bridge to Throg's Neck, has been turned in by Sub-Assistant Dorr; that containing Governor's, Ellis', and Bedloe's islands has been received from Sub-Assistant John Mechan, who was employed in the field-work last year; and Mr. Albert Boschke has delivered at the office the sheet of his survey of a part of New York city and Brooklyn.

Hydrography of Hudson river.—The regular hydrography of this river above Fishkill was resumed by Lieut. Comg. James H. Moore, U. S. N., Assistant Coast Survey, on the return of his party from Section I, early in October, in the schooner Varina. Soon after commencing work that officer was detached from service and the party was placed temporarily in charge of Lieut. Comg. Alex. Murray, U. S. N., who had also been engaged in hydrographic duty in the adjoining northern section.

Special directions having been given by the department for surveys of Esopus and Rondout creeks, the schooner Varina was transferred to their vicinity about the middle of November, and immediately took up that duty, the preliminaries for which had been provided for by the field party of Assistant Edmund Blunt. Both of those streams were thoroughly sounded out from their entrances into the Hudson to a distance of nearly two miles in the channel of the Esopus, and about three miles in that of Rondout creek. The Hudson river in the immediate vicinity, and above and below their mouths, was also sounded, and the bars which have formed at them respectively were fully developed.

This work was completed on the 2d of December, and on the return of the party to New York the results were plotted without delay. The statistics are thus given in the report of Lieut. Comg. Murray:

Angles determined	263
Number of soundings	5,018

A part of the previous occupation of the party of Lieut. Comg. Murray will be detailed in Section IV.

Complete charts of the Esopus and Rondout creeks are now on file in the Coast Survey Office.

The hydrography executed by Lieut. Comg. T. A. Craven, U. S. N., in the East river and in Harlem river has been plotted within the year.

All the records of the hydrographic work formerly in charge of Lieut. Comg. Richard Wainwright have been received from the draughtsman of the party, Mr. A. Strausz. These consist of twenty-five volumes, twelve of which contain the original entries of the soundings, and thirteen the angles as taken in the survey of Hudson river in 1855. A fair duplicate of the whole has also been turned in, with thirteen other volumes, comprising the original records of tidal observations made by the hydrographic party in Hudson river in 1854, '55, and '56.

Luddington rocks.—Early in August Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast

Survey, in passing to the site of his work in Casco bay, mention of which has been made in the preceding chapter, stopped at New Haven, Conn., and determined the position of two points of rock, information in regard to the existence of which had been communicated to me by George W. Blunt, esq., of New York. The rocks were found at the exact distance of a mile and a half (nautical) southwest by compass from the light-house at New Haven, and the entire area of their immediate vicinity was swept by soundings. Fifty-four angles were taken, and three hundred and ten casts made with the lead.

These two points of rock are reported by Lieut. Comg. Temple as lying about ten yards asunder, and as having but twelve and a half feet of water on them at low tide, while the depth around them ranges from seventeen to nineteen and a half feet. A complete chart of their vicinity has been furnished by that officer.

The particulars in regard to these dangers to navigation were transmitted to the department in September, in the usual form, for the information of the Light-house Board, as interested in the recommendation of Lieut. Comg. Temple for buoys to mark them. A copy of the communication referred to will be found in Appendix No. 12.

Investigation of the currents of New York harbor and bay, and of East river.—The series of observations for the study of the tides and currents of New York bay and harbor, and the approaches, has been carried forward under my instructions by Assistant Henry Mitchell, and is now well advanced towards completion. The Coast Survey schooners Gallatin and Bowditch, with proper equipments of boats, were assigned for this duty.

In the vicinity of Hell Gate the work of last year was so nearly complete that little remained to be done; but to the eastward, and in the neighborhood of Throg's Neck, it was found necessary to make a thorough investigation for the purpose of developing the laws that govern the meeting and separation of the two systems of tidal drifts—one derived from Long Island Sound and the other from Hell Gate. The data now in our possession promise to yield nearly all the information required for the solution of the perplexing questions which have arisen.

The examination of the bar at the entrance of New York bay, and of shoals within the harbor, formed the main project of the season, and upon that portion of the work much time and labor have been expended. The weather was so favorable that the work was prosecuted without interruption.

Among the unlooked for developments of the season is the discovery of sub-currents, differing widely both in their epochs and direction from the surface drifts. These were ascertained to be peculiar to certain districts, exhibiting themselves at some stations as counter drifts, at others as parts of extended rotatory movements. The leading phenomena seem to be presented at the return of certain tidal epochs, yet at some localities in the harbor it was observed that strong winds altered the conditions in a remarkable manner.

The current observations near the bar show most curiously the nature and arrangement of the forces which have preserved the channels from obstructions on the one hand while active in the formation of shoals and beaches on the other.

In Hudson river the tidal observations and references of the stations to each other by levelings have been completed.

Messrs. G. B. Vose and W. H. Gardner served as aids in the party of Assistant Mitchell.

In the course of the season forty-seven current stations were occupied in New York harbor and the approaches, and about thirteen thousand observations were recorded. The transfer of the vessels and boats from station to station was managed satisfactorily by Sailing Master A. C. Mitchell.

A statement more in detail of the operations of the party is contained in the report of Assistant Mitchell.—(Appendix No. 28.)

Tidal observations.—The regular series at New York has been kept up by means of one of Saxton's self-registering tide-gauges, the location of which is Governor's Island. This being subject during winter to occasional interruptions, caused by the ice, observations were at such times made with an ordinary box-gauge at Atlantic dock in Brooklyn.

SECTION III.

FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF PART OF DELAWARE, THAT OF MARYLAND, AND PART OF THE COAST OF VIRGINIA.—(SKETCH C, No. 8.)

The only work of considerable magnitude remaining to be executed in this section is the survey of the Potomac, and the topography of part of the Chesapeake bay. During the past year seven parties have been employed in parts of the surveying season—two in triangulation, three in topography, and two in hydrography.

The operations which are contained in this chapter comprise the completion of the triangulation of the Patuxent; the progress of that of the Potomac; the continued topography of the ocean shore near Chincoteague; of the shores of York river; of the James river; the completion of the sounding of the Nanticoke and Wicomico rivers and Fishing and Monic bays, Md.; of the Patuxent river, Md.

Besides computations and drawing required by the field and hydrographic operations just referred to, the following work has been done at the office in Washington.

Office work.—The following maps of this section have been completed: Chesapeake bay, (No. 32,) from Magothy river to Hudson river, Md., $\frac{1}{80000}$; and York river, from King's creek to the entrance, $\frac{1}{60000}$. The following have been in progress: Chesapeake bay, (Nos. 33, 34, 35, 36,) from Hudson river, Md., to the entrance of the bay, $\frac{1}{80000}$; the two lower sheets of Rappahannock river, from Occupacia creek to the entrance, $\frac{1}{60000}$; the upper sheet of the York river, from West Point to King's creek, $\frac{1}{60000}$; and the upper sheet of James river, from Richmond to City Point, $\frac{1}{40000}$.

The engraving of coast chart No. 31, $\frac{1}{80000}$, from the head of Chesapeake bay to the mouth of Magothy river, coast chart No. 32, $\frac{1}{80000}$, from the mouth of Magothy river to the mouth of the Hudson river, Maryland, and coast chart No. 33, $\frac{1}{80000}$, from the mouth of the Hudson to the mouth of the Potomac river, has been in progress. Rappahannock river, from its entrance to Deep creek, and Rappahannock river, from Deep creek to Occupacia creek, have been completed as preliminary, and the engraving of the map of Patapsco river has been continued. The chart of Hampton Roads and Elizabeth river and that of Norfolk harbor have been engraved upon stone, under the direction of the Superintendent of Public Printing.

Triangulation of Patuxent river, Maryland.—This work was resumed in the middle of October of last year, and has been completed by Lieutenant J. P. Roy, U. S. A., assistant in the Coast Survey. Several stations erected and used by Assistant J. E. Hilgard in the triangulation of the entrance in 1846 were recognized by Lieutenant Roy with the assistance of Lieutenant Thomas Wilson, U. S. A. The work of the season was then connected with that of the entrance of the Patuxent at two stations about midway between Sandy Point and Leonard's creek, (Sketch No. 8,) and seven of the stations used below Benedict were reoccupied. From the upper limit reached last year the triangulation was continued up the river to within a mile of Nottingham, completing the preliminary work requisite for a topographical survey of the river.

Nineteen new stations were occupied by Lieutenant Roy, and twenty triangles measured by about two thousand observations.

The stations erected during the present and previous season were marked by granite blocks, the usual precautions being taken to secure their permanence. The triangulation was completed on the 8th of December, when the schooner J. Y. Mason, which had been used by the party for transportation, returned to Baltimore.

During the winter Lieutenant Roy was engaged in the computations of his field-work, and has been subsequently employed in the office.

A duplicate of the record of horizontal angles measured in the triangulation of the Patuxent river has been made by Lieutenant Roy, and placed with similar data for reference.

Lieutenant A. H. Seward has furnished descriptions of the signals last used in the triangulation of Chesapeake bay.

Triangulation of the Potomac river, Virginia.—Early in May Assistant John Farley commenced work at the mouth of the Potomac, making a connection with the main triangulation of Chesapeake bay and erecting stations for carrying the preliminary survey of that river upwards from its entrance. A series of triangles (Sketch No. 8) was projected, covering the lower part of the Potomac and extending to Piney Point. The entrance to the St. Mary's river was also included in the scheme, and properly connected with the main triangulation of the river. After measuring the angles Assistant Farley computed the positions of his signals and forwarded the results to the office.

The schooner Guthrie was employed by the party for transportation. At the close of operations on the 1st of August the vessel was laid up at Baltimore. Assistant Farley then took up his office computations and the duplication of the records of the work. His report contains the following abstract of statistics :

Stations occupied	13
Angles measured	47
Number of observations	1,405

Sub-Assistant S. A. Wainwright assisted Mr. Farley in the triangulation at the mouth of the Potomac.

At this date the party is about resuming work near Piney Point.

The record of horizontal angles determined in the triangulation of the Curratoman river in 1857 has been duplicated by Assistant Farley and sent to the office. He has also furnished descriptions of the signals used in that work, and computations of the results for L. M. Z. and triangle sides.

Topography of Chincoteague island and the coast opposite, Virginia.—This work, in which some progress was made last year, has been completed by the party of Sub-Assistant Charles

Ferguson. The topography of the western side of Chincoteague bay was commenced on the 12th of July near Snead Signal, and finished from Watt's bay northward to Long Point, the shore-line being continued several miles further to George Island road, where the work connects with a plane-table sheet executed in 1849. "Chincoteague island, which is in length about eight miles and a half, was also entirely surveyed. Its topography was tedious and difficult, in consequence of the broken and varied character of the surface, which embraces in its delineation almost every variety of detail."

Having been informed of the intention of the commissioners appointed by the States of Maryland and Virginia to visit and examine the eastern part of the boundary line between those States in the vicinity of Chincoteague island, direction was given in regard to details with reference to the possible requirements of the commission. These have been fully carried out by Sub-Assistant Ferguson, who also furnished such information as he had incidentally gathered while prosecuting plane-table duty. A portion of the inside shore-line of Assateague island was traced by the party. Field-work was closed on the 30th of September, when the following statistics were reported:

Shore-line surveyed	35 miles.
Roads	45 "
Creeks	30 "
Area in square miles	26

The topographical sheet executed by Sub-Assistant Ferguson completes the survey of the main coast of Virginia, in the vicinity of the northern boundary line. Immediately after his return to Washington it was inked and placed in the archives. The limits included are shown on Sketch No. 8.

A plane-table sheet executed by Sub-Assistant N. S. Finney last season, containing Chincoteague inlet and part of the shores of Chincoteague bay and island, has also been turned in.

Topography of York river, Virginia.—The plane-table survey of this river has been completed by the party of Assistant John Seib. At the close of last season the work terminated in the vicinity of Bigler's Mill, and was there resumed on the 2d of August. The schooner Bailey was used for transportation. Advancing up the river, Mr. Seib completed the shore-line and topography falling within the triangulation of Lieutenant J. P. Roy, U. S. A., as far as West Point, and extending his work a short distance beyond it on the Pamunkey and Mattaponi rivers. The following summary is extracted from the report of Mr. Seib:

Shore-line surveyed	54¼ miles.
Roads	6 "
Area of topography (in square miles)	11

Towards the end of August the vessel was found to be leaking, but temporary repairs at Norfolk enabled Mr. Seib to move the party to another site of work on the shore of Chesapeake bay.

The lower sheet of the survey of York river, executed last year, has been inked and deposited in the office. Sketch No. 9 is a reduction from the sheet of this season.

Topography of Mobjack bay, Virginia.—During the month of September the party of Assistant Seib was employed in tracing the northern shore-line of this dependency of

Chesapeake bay, between New Point Comfort and East river. The southern shore-line was traced previously.

At the close of work on the 12th of November, the detailed topography had been extended along the northern shore from the entrance of the bay upwards, and beyond the mouth of East river, both shores of which (Sketch No. 8) are also included in the plane-table sheets.

The following is a synopsis of the statistics :

Shore-line surveyed	30 miles.
Roads	18 "
Area (square miles)	8

In the middle of November the schooner Bailey, which had been used for transportation, returned to Baltimore and was refitted for other service. Assistant Seib then made arrangements preparatory to resuming duty in Section V.

Topography of Richmond, Virginia.—As part of the data necessary to complete the map of James river, a plane-table survey was made, during the winter, of the city of Richmond. Sub-assistant S. A. Wainwright commenced this work in November, and was succeeded in the following month by Assistant I. Hull Adams, who completed the survey.

Mr. G. U. Mayo served for a short period as aid in the party of Mr. Adams.

The topographical sheet has been inked and returned to the office. It contains the characteristics of the area represented, which is about two and a third square miles.

Hydrography of Nanticoke river, Md.—The work in this tributary of Tangier sound was commenced by Commander W. T. Muse, U. S. N., Assistant in the Coast Survey, early in September, after the return of the steamer Hetzel from Section IV, and being prosecuted under favorable circumstances of weather was completed on the 17th of that month. The hydrographic sheet will join at the entrance of the river with one of Tangier sound, partly executed in a former season by Lieut. Comg. J. J. Almy, U. S. N., and in the same vicinity, with two others subsequently laid out by Commander Muse, to include the head of the sound, known as Fishing bay, and to the eastward of the Nanticoke, Wicomico river, and Monic bay. In a northeasterly direction the soundings of the Nanticoke were extended upwards as far as Vienna, (Sketch No. 8,) about fifteen miles in a direct line from the mouth of the river. A summary of statistics is thus given in the report upon the completion of the hydrography:

Miles run in sounding	368
Angles determined by the sextant	767
Number of soundings	28,260

Hydrography of Fishing bay, Md.—In the latter part of September Commander Muse having made a junction with the upper limit of the hydrography of Tangier sound, as left by Lieut. Comg. J. J. Almy, and with his own sheet of work, which includes the Nanticoke river, commenced soundings in Fishing bay, and proceeding upwards finished the hydrography of that and, at intervals, of another branch of the sound by the middle of October. The details of the work in Fishing bay are as follows:

Miles run in sounding	246
Angles determined	1,139
Number of soundings	14,146

Seven hundred and twenty-four observations on high and low water were recorded while the work was in progress.

Hydrography of Wicomico river and Monic bay, Md.—The soundings made in this locality by the party of Commander Muse extend from the limit of the general hydrography of Tangier sound, executed by Lieut. Comg. Almy, in 1856, as far up as White Haven, on the Wicomico, and embrace the whole of the tributary designated as Monic bay. This supplementary work was completed early in October. The following is a synopsis of the statistics:

Miles run in sounding	97
Angles determined	456
Number of soundings	5,868

Tidal observations were made by the hydrographic party, as usual, for the adjustment of the soundings.

Hydrography of Manokin river, Md.—The circumstances of the weather favoring, Commander Muse took up the hydrography of Manokin river, one of the eastern arms of Tangier sound, and completed that work in the latter part of October, making a proper junction with the sheet containing the work done in a previous year in the body of the sound. But a small part of the subsidiary hydrography of this vicinity yet remains to be done. The following is an abstract of the statistics recorded on the sheet of the Manokin:

Miles run in sounding	101
Angles determined	1,024
Number of soundings	7,445

At the end of the surveying year the party in the steamer Hetzel returned to Baltimore, where that vessel is now undergoing repairs.

Early in the season Commander Muse sent to the office the original records of soundings, angles, and tides observed in the progress of the work in the Patuxent river in 1857. The volumes were accompanied by a fair duplicate.

The original journals of soundings, angles, and tides observed while prosecuting the hydrography of the St. Mary's river, Md., in 1857, and a duplicate of the whole, have also been received from Commander Muse and deposited in the office.

The office-work resulting from hydrographic operations formerly in charge of Lieut. Comg. R. Wainwright in this section has been completed. Six sheets of the lower part of the Rappahannock river, and one containing the soundings made in the Curratoman, have been received and filed in the archives, with the original volumes and duplicates of the soundings, angles, and tides taken in the progress of the work.

In anticipation of his detachment, the office-work of the party of Lieut. Comg. J. N. Maffitt was vigorously prosecuted and brought up before his separation from the Coast Survey. Three sheets comprising the soundings last made in the James river were plotted under his direction and left at the office in April last, together with twenty-seven volumes containing the original notes of soundings, angles, and tidal observations. Smooth duplicates accompanied the records referred to.

Tidal observations.—The usual observations have been continued at Old Point Comfort with Saxton's self-registering tide-gauge. A similar gauge has been put up at the Washington navy yard, by authority of the Hon. Secretary of the Navy. Every facility for its erection and for keeping up the observations was afforded by Commander Dahlgren and the officers in charge of the ordnance department of the yard.

SECTION IV.

FROM CAPE HENRY TO CAPE FEAR, INCLUDING THE COAST OF PART OF VIRGINIA AND NORTH CAROLINA.—(SKETCH D, No. 10.)

In order to determine the question whether the small triangulation along this coast will answer the purpose of a final work, or must be strengthened or replaced by a larger one, several sites for bases of examination have been selected in reference to the convenience of measurement and of access, and with regard to portions of the triangulation itself. The topography of the ocean shore of the section has been nearly completed. The hydrography of Pamplico sound and of the ocean westward of Beaufort entrance, N. C., has been continued, and some incidental work between Cape Hatteras and Cape Fear has been executed. The details are stated in the following chapter. Six parties have been at work, three during the whole, or nearly the whole, of the season, and three during a part of it.

In addition to the computations resulting from the field-work, the following has been done at the office at Washington.

Office-work.—The following sketches have been drawn during the year: Hatteras inlet, $\frac{1}{20000}$; and Ocracoke inlet, $\frac{1}{30000}$. A general chart of the coast from Currituck sound to Cape Fear, $\frac{1}{400000}$, has been commenced, and the two preliminary charts, Nos. 11 and 12, extending from Cape Hatteras to Cape Fear, $\frac{1}{200000}$, have been in progress.

The engraving of Beaufort harbor, N. C., and the entrance to Cape Fear river has been completed. Progress has been made upon coast chart No. 41, $\frac{1}{80000}$, from the entrance of Albemarle sound to the mouth of Pasquotank river, N. C., and on preliminary chart No. 11, $\frac{1}{200000}$, from near Cape Hatteras to near Bogue inlet.

Triangulation southward of Cape Henry, Va.—The connection desirable between this work and the main triangulation of the Chesapeake bay was attempted at the end of January by Assistant J. J. S. Hassler, but the inclemency of the weather rendered its final completion impracticable. Mr. Hassler kept the field until the 10th of May, when he was taken seriously ill and was forced to remove from his camp. Earlier in the season one of his arms had been broken by an accident, from the consequences of which, as aggravated by the illness referred to, he died at Norfolk on the 23d of June. The records and journals of his field-work, with some plane-table sheets of the seacoast tract extending southward from Cape Henry, have not yet come into my hands. Application has been made for them in the proper quarter, and a summary of the results of his season's work will be given at the earliest moment after the receipt of the necessary data.

Verification bases, coast of North Carolina.—The whole line of triangulation running along the coast from Cape Hatteras southward to Cape Fear has been examined by Assistant A. S. Wadsworth, and sites for bases of verification selected at intervals to serve as checks upon that work. He commenced early in January, and established six bases in all for future measurement, making preliminary connections with adjacent stations of the triangulation. The first of these was marked out on the outer beach of Core sound, opposite Bell's Point, a short distance above Cape Lookout light-house. Others were established on the coast (Sketch No. 10) south of Bogue inlet; in the vicinity of New river; near New Topsail inlet; at Masonboro inlet; and near Federal Point.

Considerable changes were found to have been occasioned along the beaches of Bogue sound and Masonboro inlet by the severe gale of September, 1857.

The signals generally were in good condition, as left in the previous season, yet several of them, necessary for the work of verification, required to be reset and secured.

In the vicinity of Cape Hatteras, at Brown's inlet, and at New inlet, the angles of the preliminary triangulation were remeasured, and new stations erected where necessary. From twenty-six stations twenty-seven signals were observed upon, and in the several localities fifty-two angles were measured by two thousand one hundred and fifty-six observations. The instrument used was the six-inch Brunner theodolite C. S. No. 59.

Assistant Wadsworth was occupied in this duty until the middle of May. He has since furnished detailed descriptions of the base sites and computations of his field-work, which have been deposited in the office, together with a duplicate and the original record of horizontal angles measured between Cape Hatteras and Cape Fear in 1857; his computation of the lengths of triangle sides and descriptions of the signals erected between the points just mentioned.

Topography of the seacoast southward of Cape Henry, Va.—Within the triangulation in charge of Assistant J. J. S. Hassler, and which was approaching completion at the time of his death, a plane-table sheet was projected by Mr. F. R. Hassler, then serving as aid in the party. It connects on the north with a sheet previously laid out, and extends southward to Green Branch, at the head of Back bay. The seacoast of Virginia is included down to the southern boundary line, and also Ragged island, lying in the upper part of Currituck sound. All the roads and other prominent topographical features falling within the limits of the recently executed triangulation are represented on the plane-table sheet.

This work was prosecuted, between the end of January and the 10th of June, as actively as the inclemency of the season and the nature of the country would permit. The character of the surface is low and swampy, and cut up by numerous ponds and water passages. The details comprise twenty-five miles of shore-line and fifty-five miles of roads. Arrangements have been made for the completion of the plane-table survey in this vicinity.

Topography of the seacoast of North Carolina.—The intervening space between New inlet and Cape Fear, remaining unfinished at the opening of the season, has been surveyed by the party of Mr. John Mechan. His plane-table work (Sketch No. 10) comprises a part of Topsail sound and the outer coast of North Carolina, stretching about eleven miles in a southwesterly direction between Stump inlet and Long Point. The term "sound," used in reference to several localities between New inlet and Federal Point, applies to an intricate combination of shallow creeks, narrow channels, and broken marshes, running with an average width of a mile and a quarter, parallel with the outer coast, separated from it by narrow ranges of sand hills.

"These sandy barriers within the limits just stated have been pierced in five places by heavy gales. Two of the small inlets so formed and connecting with the interior sounds are much resorted to for shelter by small coasters. They are known as New Topsail and Masonboro inlets. Channels leading from them to the main land are navigable for small craft; but at few other points along this part of the coast is there sufficient water for even a pilot boat."

In reference to changes made by the action of the sea since the previous working season, Mr. Mechan also states that "the gale of September, 1857, closed up Stump inlet and opened another a little further north, but did not very materially alter the general configuration of the coast or the other inlets."

The operations of this party commenced on the 18th of November, and were concluded on the 14th of January, with the following result:

Coast line surveyed	$11\frac{3}{4}$ miles.
Shore-line of sound	102 "
Shore-line of creeks	30 "

The weather was very favorable for work during the stay of the party in this section. Having properly connected the topography with that already finished in the direction of Cape Fear, Mr. Mechan proceeded to Section VI, under which head his labors will be further noticed.

Hydrography of Pamplico sound, N. C.—The inside soundings above Ocracoke inlet were resumed in the middle of June by the hydrographic party of Commander W. T. Muse, U. S. N., assistant Coast Survey, with the steamer Hetzel. Northward and eastward of the inlet, and (Sketch No. 10) from a line beyond the middle of the sound, the work was continued upwards to a parallel a short distance north of Gull island. This space includes the greater part of the interior of Pamplico sound, immediately abreast of Cape Hatteras. At the lower limit the sheet containing the soundings joins with one executed last year just inside of the Ocracoke entrance. Below Ocracoke inlet the hydrography was continued to the meridian of Harbor island, about five miles southward and westward of the limit reached last year.

The work in Pamplico sound was discontinued on the 31st of July. An abstract from the report of Commander Muse gives the following statistics:

Miles run in sounding	1,225
Angles observed	3,677
Number of soundings	56,335

One hundred and fifty-eight specimens of bottom were collected while the soundings were in progress.

The condition of the steamer Hetzel not admitting of her employment in the prosecution of the outside hydrography in the vicinity of Cape Hatteras, as intended, Commander Muse returned to Norfolk early in August, with a view of fitting her for that duty. This not being then practicable, he took up hydrographic work in Section III, as already stated.

The original hydrographic sheets resulting from the soundings made by Commander Muse, at Hatteras and Ocracoke inlets, in 1857, have been completed and filed in the office. He has also turned over for deposit the original journals of those surveys, and others containing the soundings and angles taken in the same year in the hydrography of Pamplico sound.

Hydrography of the coast of North Carolina.—In continuation of the soundings which terminated last season along a line passing westward of Beaufort entrance, N. C., Lieut. Comg. C. R. P. Rodgers, U. S. N., assistant in the Coast Survey, resumed active operations in the steamer Bibb, on the 9th of April.

The in-shore hydrography has been extended in a westerly direction to a distance of about fourteen miles, or nearly three miles westward of Bogue inlet, (Sketch No. 10,) which was also sounded, and will appear on the resulting chart of this quarter.

While the work here noticed was in progress Lieut. Comg. Rodgers was detached from the Coast Survey, being relieved by Lieut. Comg. Alexander Murray, U. S. N., who assumed the command of the party on the 28th of April, and continued its operations until the close of the season at the end of May.

In prosecuting the in-shore hydrography a number of parallel lines were run at increasing intervals from the coast, the outermost ranging with it at a distance of about seven miles. These were crossed by ten others, averaging twelve miles in length, extending broad off from the land. In addition, four lines were started within the in-shore limits and run with soundings into deep water, two of them terminating about fifty miles from shore, and two at a distance of thirty-three miles. "The bottom was found very uniform, showing a gradually sloping surface of hard sand and loose coral, (Milleporae ?")

A synopsis from the journals shows the following statistics:

Angles determined	677
Miles run in sounding in-shore	3,025
Number of in-shore soundings	5,995

The usual tidal observations were made by the party for hydrographic purposes.

Before leaving the vicinity a section was run across the Gulf Stream from Cape Lookout, but surface temperatures only were obtained. In July the party in the steamer Bibb resumed hydrographic duty in Section I, as stated under that head.

The in-shore soundings made by the party of Lieut. Comg. Murray along the coast of Bogue sound and inlet have been plotted, and the resulting sheet is now in the office.

On the outward passage of the surveying steamer Walker to Section VIII, Commander B. F. Sands, U. S. N., assistant in the Coast Survey, carried a line of soundings from off Cape Hatteras to the latitude of Cape Fear, making thirty casts of the lead in a run of a hundred and eighty miles. The intention was to continue the soundings incidentally along the edge of the Gulf Stream; but a strong northeast gale off Cape Fear compelled the vessel to scud on her course to Cape Cañaveral, and rendered the original design impracticable.

A more extended notice of interesting results obtained by Commander Sands in another locality will be made under the head of *Gulf Stream.*

SECTION V.

FROM CAPE FEAR TO ST. MARY'S RIVER, INCLUDING PART OF THE COAST OF NORTH CAROLINA, AND THE COAST OF SOUTH CAROLINA AND GEORGIA.—(SKETCH E, No. 14.)

The survey of this section has advanced very considerably during the past year. Nine parties have been employed, namely: two for triangulation, one for triangulation and topography, four for topography, and two for hydrography; seven of the entire number in different parts of the section during the whole and two of them during part of the season.

The work executed will be referred to under the following heads:

1. Triangulation and topography of the coast of North Carolina westward of Bacon's Inlet.
2. Triangulation of the coast of South Carolina, connected with general work north and south of Charleston.
3. Triangulation of Ossabaw and St. Catharine's sound, Ga.
4. Plane-table resurvey of shore-line at the Cape Fear entrances.

5. Topography of Winyah bay and Georgetown harbor, S. C.
6. Resurvey of the shore-lines of Charleston harbor.
7. Topography of Folly Island, S. C.
8. Topography of St. Helena sound, S. C.
9. Topography of Ossabaw sound, Ga., including the shores of its tributaries.
10. Topography of Sapelo sound and river, Ga.
11. Topography of Brunswick harbor and Turtle river, Ga.
12. Hydrography of the Cape Fear entrances and bars.
13. Resurvey of Maffitt's channel.
14. Off-shore soundings from the coast of South Carolina.
15. Hydrography of Sapelo sound and river, Ga.

A connection has been made through the chain of secondary triangles between the preliminary base at Winyah bay and that on Savannah river, with very satisfactory results, as will be seen by the more particular statement under the head of field-work in this section.

The greater part of both in and off-shore hydrography of the northern part of the section (coast of South Carolina) is completed, important observations of currents remaining, however; some off-shore work, and the in and off-shore hydrography north of Winyah bay.

The triangulation of the coast of North Carolina, south of the Cape Fear, is a tedious operation, the woods reaching to the very ocean shore, and the sounds which give facilities to the work further north and south being in this portion entirely obliterated. Notwithstanding this a very steady progress has been made both in the triangulation and topography of this difficult district.

The resurvey of Maffitt's channel has shown that the dredging there has been effective in still further improving the depth, and in facilitating access by this important entrance to Charleston harbor.

Between Tybee entrance, the mouth of Savannah river, and St. Mary's, on the coast of Georgia, are eight inlets of greater or less importance from the depths of their channels, their peculiar relation to the inland passages along the coast, and from the importance of the rivers to which they give access.

These inlets are Wassaw, Ossabaw, St. Catharine's, Sapelo, Doboy, Altamaha, St. Simon's, and St. Andrew's. Wassaw is important as the passage between Savannah river and the ocean for vessels which cannot go through the Romerly Marshes passage; Ossabaw is the entrance to the Vernon and Great and Little Ogeechee rivers ; St. Catharine's, to the Medway or Sunbury, and to North Newport river; Sapelo, to South Newport and Sapelo rivers; Doboy gives access to Darien and the Altamaha river, Altamaha inlet being an inferior one; St. Simon's, to Turtle river and Brunswick, and St. Andrew's to the Satilla.

The inland passage from Savannah river to the St. Mary's, now so useful to commerce, becomes, in the event of war, of inestimable value. The progress of the survey of the passage and inlets has been steady. Reconnaissances of St. Andrew's and Doboy, and complete surveys of Tybee, Sapelo, St. Simon's, and St. Mary's have been made. The triangulation of Wassaw, Ossabaw, and St. Catharine's is complete, and the topography of Ossabaw, so that three or four seasons more will complete the land work generally connecting the several triangulations now in part resting upon local bases. The connection has been made this season between the

Savannah river and Sapelo preliminary bases, and has proved quite satisfactory. There remain for triangulation Doboy and Altamaha, and their branches, to Darien, St. Andrews and the adjacent coast, and thence on to Cumberland sound. The connection will then be complete from the Savannah river to the St. Mary's.

A small steam vessel of light draught was purchased to execute the hydrography of the inland passages, sounds, and rivers of this section, but the stormy character of the last autumn, winter, and spring, prevented her transfer from New York to the southern coast. The attempt was renewed this season, the vessel being placed in charge of Lieutenant B. E. Hand, U. S. N., one of the officers of the hydrographic party of Lieut. Comg. Moore. The little vessel left New York on the 2d of August, but meeting with many adverse circumstances on the way put into Delaware bay, into Norfolk, and into Beaufort, N. C., and weathered there the gale of September 15th and 16th, with slight damage. Serious apprehensions were entertained at one time for her safety, but she reached Charleston without further difficulty.

Office-work.—The drawing of a comparative chart of each of the Cape Fear entrances, (1853 and 1858,) and of the charts of St. Helena sound, $\frac{1}{40000}$; St. Mary's bar and Fernandina harbor, (Ga. and Fla.,) $\frac{1}{20000}$; St. Simon's sound and Brunswick harbor, (second reduction,) $\frac{1}{40000}$; additions to Charleston harbor, $\frac{1}{30000}$; (resurvey of the city) and Bull's bay, $\frac{1}{40000}$, has been completed. The finished map (No. 53) of the coast of South Carolina, embracing Charleston harbor and vicinity, from Rattlesnake shoal to St. Helena sound, $\frac{1}{80000}$, has been in progress.

The engraving of the preliminary chart No. 14, $\frac{1}{200000}$, from Cape Roman, S. C., to Tybee island, Ga., St. Simon's sound and Brunswick harbor, and St. Mary's river and Fernandina harbor, has been completed.

The preliminary chart of Bull's bay and Roman inlet, that of St. Helena sound, and a comparative chart of the Cape Fear entrances (1853 and 1856) have been engraved upon stone, under the direction of the Superintendent of Public Printing.

The records of latitude observations made in 1854 by Dr. B. A. Gould, jr., and G. W. Dean, assistants, at Columbia, S. C., have been received at the office.

Triangulation and topography of the coast westward of Bacon's inlet, N. C.—The party of Assistant C. P. Bolles resumed work on the 3d of December, and continued the triangulation and plane-table survey detailed in my last annual report as having been prosecuted jointly to the westward of Lockwood's Folly, N. C. Progress was materially retarded by frequent rains, but the weather otherwise was mild, and the party was actively engaged until the 6th of April in extending the secondary triangulations (Sketch No. 14) west of the line of Fulford, — Lancaster, in running the outline of roads, sketching surface features, and erecting signals for advancing the work. "The lengths of the sides of triangles now extended average a mile and a half, and it is hoped that it may be practicable to keep up that gauge as far as the southern boundary of the State." The triangulation and topography are now both complete to Shallotte inlet.

Six stations of the second order and fifteen of the third were occupied, and a hundred and twenty-eight angles were measured on forty-two objects by six hundred and fifty-two repetitions.

The gale of last autumn having occasioned a very material change in the shore-line at Bacon's inlet, that portion of the topography of last season was resurveyed. Assistant Bolles reports that the shore-line for hydrographic purposes is now complete as far as Tubb's inlet, twenty-five and a half miles to the westward of Cape Fear river.

The plane-table statistics are thus given in his report:

Shore-line of sound and beach	9.5 miles.
Shore-line of creeks	7.3 "
Roads surveyed	13.5 "
Chained in reconnaissance	5.7 "

Mr. O. Hinrichs served as aid in the party, and his duties are referred to by Assistant Bolles as having been performed with energy and success.

Three plane-table sheets containing the topography between Cape Fear and Bacon's inlet were inked early in the season and sent to the office by Assistant Bolles.

Triangulation of the coast of South Carolina.—A connection has been made, by secondary triangulation, between South Island base, Winyah bay, and the base on Savannah river.

In its progress southward this work (Sketch No. 14) embraces the whole of Winyah bay and Georgetown harbor, the North and South Santee rivers, Bull's bay, and the coast throughout, including Charleston harbor, south of which it proceeds in two series, one passing down the coast, the other following the Stono and North Edisto rivers along the inner verge of the primary triangulation to the South Edisto river, beyond which it stretches over St. Helena sound and Port Royal entrance, and through Calibogue sound to the base on Union causeway opposite to Savannah. While occupying stations upon Broad river, a tertiary triangulation was carried up Beaufort river as far as Archer's creek, and the positions determined of all the hydrographic stations used in the survey of that river in 1855 which could be identified.

During the present season six stations were occupied between Georgetown light and Bull's bay, and twenty-five in completing the connection with the secondary work passing through Calibogue sound with that on Savannah river.

Assistant Boutelle was aided by Mr. H. S. Du Val. His party used the surveying schooner Petrel for transportation. The operations of the present year were commenced on the 22d of December and closed in the middle of April, the vessel being then laid up at Charleston.

A summary of statistics is thus given in Mr. Boutelle's report:

Angles measured	270
Objects observed on	272
Number of observations	2,681

The angles were measured with the ten-inch No. 43, and eight-inch No. 24, Gambey theodolites.

Assistant Boutelle has deposited in the office a duplicate of his field-notes of horizontal angles measured between Winyah bay and Charleston, and a volume containing descriptions of the signals used in the triangulation. The records of the secondary triangulation between St. Helena and Calibogue sound, with descriptive notes of the signals erected for that work, have also been received.

Mr. Boutelle brought the computations of his work to a close in September, and selected a side of one of the triangles at the head of Calibogue sound for comparing the results of the triangulation executed by Lieutenant D. T. Van Buren northward from Savannah in 1854 with his own of this season. The comparison shows a very close agreement between the two branches, each proceeding from separate and independent data. The agreement of the azimuths is remarkably close.

Triangulation of Ossabaw and St. Catharine's sounds, Ga.—Ample preparations for the completion of this work, and for connecting it with the general triangulation of the coast at Savannah river, had been made last season by the party of Lieutenant A. W. Evans, U. S. A., assistant in the Coast Survey. The stations were mostly then selected and signals put up on the shores of Ossabaw and St. Catharine islands, and along the banks of the several tributaries of the sounds.

The triangulation party in the schooner Hassler resumed operations in the field on the 10th of December, and before the close of that month was joined by Lieutenant Evans. He immediately pushed a reconnaissance for extending the work so as to connect with the triangulation of Sapelo sound, and then occupied successively with the theodolite ten stations of the second order and twenty-one of the third. Seventeen other stations were erected and their signals observed on. The positions of sixty-three points were accurately determined in the course of the work. A few desirable points yet remain to be determined along the beaches of St. Catharine and Ossabaw islands.

The services of Lieutenant Evans being called for by the War Department, he was detached from duty in February. Mr. F. P. Webber, who had assisted him during the season, having been also qualified by several years experience in similar duty, continued the work and closed it on the 1st of April. Since that date he has completed the computations of the field-work executed by Lieutenant Evans in 1856–'57 for connecting the Savannah River triangulation with that of Ossabaw, and during the summer was engaged in those of the present year.

The connection between Savannah river and the preliminary base on Sapelo island (Sketch No. 14) was effected by the measurement of sixty-seven intervening triangles, and the field computation gives for the length of that base 1700.47 metres, which is only two tenths of a metre less than the length found by measurement.

The triangulation of this season stretches from the north side of Ossabaw sound southward and westward, and includes the various dependencies of that and the adjoining sounds, known as Great and Little Ogeechee and Bear rivers, Medway or Sunbury river, North and South Newport and Timmins rivers, the opening of Mud river inside of Sapelo island, and numerous intricate water passages lying behind Ossabaw and St. Catharine islands. A synopsis of the statistics is given below, as stated in the report from the field:

Angles measured	379
Objects observed	349
Single observations	4,095

From points furnished by the triangulation the topography of Ossabaw sound has been executed, as will be noticed hereafter.

While engaged with his party Lieut. Evans seized the occasion of rendering assistance to the ship Mackinaw when ashore on Ossabaw bar.

The duty executed by the party in charge of Mr. Webber in the latter part of the surveying year has been stated under Section I.

All the records and field notes connected with the triangulations made by Lieut. Evans in this and in the adjoining lower section have been received at the office. They contain the original entries of horizontal angles observed at Sapelo sound, notes on the measurement of the preliminary base there, descriptions of the signals used in the triangulation, and the field computation for rectangular co-ordinates and lengths of triangle sides. Similar data collected in the progress of work at the St. Mary's River entrance have been also turned in.

Sub-Assistant Webber has forwarded duplicates of the journals of horizontal angles measured and descriptions of the signals used in the triangulation of Ossabaw and Sapelo sounds, with his computation for the lengths of triangle sides.

Topographical resurvey of Cape Fear entrances.—A commission having been appointed to investigate the character and causes of the changes going on at New inlet and at the southern entrance to the Cape Fear river, and new data being required for the necessary comparisons, Assistant C. P. Bolles was directed to make a thorough plane-table resurvey of the shores of the entrances and the adjacent banks, including Federal Point and Zeek's island. This duty was performed between the 8th of April and the 31st of May, and the results were at once furnished to the hydrographic party then engaged in a re-examination of the channels.

Mr. O. Hinrichs aided Assistant Bolles in the plane-table work. The following statistics are derived from the sheets of the resurvey:

Shore-line of beach determined	19.4 miles.
Shore-line of marsh	2.5 "

This party had been, in the early part of the season, employed in pushing the regular survey of the coast of North Carolina below Lockwood's Folly.

In prosecuting the resurvey at Cape Fear Assistant Bolles occupied eighteen stations with the theodolite, and made two hundred and fifty-five observations for topographical and hydrographic purposes. Twelve signals were erected in the course of these operations.

The shore-line changes which have occurred in that vicinity since 1853 will be seen by referring to the comparative charts (Sketches Nos. 12 and 13.) Special reference is made to them in Appendix No. 14.

Topography of Winyah bay and Georgetown harbor, S. C.—Assistant H. L. Whiting left Charleston for this duty on the 16th of January, and, being favored by good weather, completed the plane-table survey by the 8th of the following month. A party organized by Assistant Seib, whose health would not admit of field service at that time, was employed in the work, and the surveying schooner Graham was used for transportation.

The survey made by Mr. Whiting was carried along the ocean shore about three miles north and the same distance south of the inlet, and continued upwards so as to embrace both shores of Winyah bay, the shores of Georgetown harbor to its junction with the Pedee and Waccamaw rivers, the city of Georgetown, and the adjacent shores of Sampit river.

Of the outer coast the principal features, as hammocks, sand hills, &c., ranging northward from Light-House Point, are included on the topographical sheet, (Sketch No. 14,) and in this direction the high-water shore-line was traced about three miles beyond the limit of the detailed work. The corresponding details of the outer side of South island are also represented. From the entrance the survey was made to embrace as much of the shores of the bay as could be commanded by a thorough series of shore stations, and all the characteristics of formation likely to be of service as leading marks in navigation. The Marsh islands in Winyah bay, and Rabbit and Hare islands in Georgetown harbor, are shown on the plane-table sheet.

"The distance from the bar to Georgetown, following the general course of the bay and river, is about fifteen miles. The inlet proper, between North and South islands, is about three-quarters of a mile wide, gradually swelling into the main bay, which is about four miles wide by five in length. Above the Marsh islands the bay gradually narrows to a mile and a half, and that width is retained to the fork of the Waccamaw and Pedee rivers."

Aggregates of the details of his plane-table work are thus returned by Assistant Whiting:

Shore-line surveyed	64 miles.
River banks	36 "
Marsh-line	16 "
Streets and wharves	$9\frac{1}{2}$ "

The limits of the topography comprise an area of thirty square miles.

After concluding this survey Mr. Whiting reviewed and verified the recent topographical work on St. Helena sound, and reported at the office in the middle of February. He then inked his outstanding plane-table sheets of the vicinity of New York city, and afterwards resumed field duty in that quarter.

Topography of Charleston harbor, S. C.—The resurvey of this vicinity, commenced last year by Mr. W. S. Edwards, was prosecuted by him during the working season of the present surveying year, under the general direction of Assistant C. O. Boutelle, to whose party he was attached. The whole of the south side and about half of the northern shore-line of Sullivan's island was retraced, as well as the main shore of the harbor from Haddrell's Point, along the north side to Cooper river, and a portion of its eastern bank opposite to the city of Charleston. The entire water-line of the city was resurveyed, and the opposite shore of Ashley river. On the south side of the harbor the plane-table work was extended eastward to Light-house creek, the work there forming a junction with the sheet of Sub-Assistant Iardella, which will be presently referred to.

Shute's Folly and Drum island, opposite Charleston, were also surveyed by Mr. Edwards. His party was employed in this duty between the 1st of December and the end of April. The following statistics are returned as the result of its operations:

Shore-line surveyed	$32\frac{1}{2}$ miles.
Roads	30 "
Area of details in square miles	$3\frac{3}{4}$

The various improvements made in the vicinity of the city of Charleston since 1849, and changes brought about by natural causes, are represented on the plane-table sheet.

"On Sullivan's island the inner shore-line remains nearly the same. The outer shore-line shows great changes from Bowman's jettee. The high-water mark has receded ten metres, and is now nearly a straight line to the first point of the island, where the high-water mark of 1858 is one hundred and twelve metres back of that of 1849. From thence to the second point of the island the high-water mark has made out sixty-four metres, and the tendency is to straighten the outer shore-line. The southeast end of the point at Breach inlet has washed away for a space of twenty metres, and on the inside of the jettee and opposite Fort Moultrie the high-water line has made out thirty-three metres."

After inking and turning in his topographical sheet Mr. Edwards joined Assistant Boutelle for duty in Section I.

Morris' island, lying on the south side of the entrance to Charleston harbor, was resurveyed in March by Assistant John Seib. Considerable changes were observed to have occurred since the survey of 1848, chiefly at Cummings' Point, forming the northern extremity of the island. There the shore-line has encroached about a hundred and thirty metres on the land. Of the signals used in the former plane-table survey, one, which stood on a sand hill forty metres from high-water mark, has washed away, and its projected position coincides nearly with the low-water line. The whole outer coast-line has receded slightly; but near Light-house Point, the southern termination of the island, a breadth of two hundred metres has been entirely cut off. A corresponding prolongation of Light-house Point to the extent of two hundred and seventy metres southward has occurred.

Slight alterations were detected also along the southern shore of Charleston harbor and in the topographical details of the interior of Morris' island.

Mr. Seib was aided in this resurvey by Mr. C. Rockwell. On the resulting sheet the following synopsis of statistics is recorded:

Shore-line surveyed	39 miles.
Area, (square miles)	$9\frac{1}{2}$

The revised shore-line was applied to the new edition of the chart of Charleston harbor which accompanies this report as Sketch No. 16.

This work (Sketch No. 14) connects on the southward with the survey which will be next described.

Topography of Folly island, S. C.—The party of Assistant Seib left Charleston harbor on the 2d of April, with the schooner Graham, and in the course of that month executed a plane-table survey of the whole of Folly island from Light-house inlet southward and westward to Stono inlet. Both shores of the water passages separating the island from others lying between it and the main land were traced throughout. The topography also of the northern shores of Stono inlet and its southern shore-line, in communication with the mouths of Stono and Kiawah rivers, were executed.

The work was extended from the coast about two miles up Light-house inlet, and includes an average breadth of a mile and a half, ranging with the outer coast of Folly island.

Of this quarter of his operations, Assistant Seib remarks: "The country is low and marshy, interspersed with many hummocks, and intersected by numerous water courses and extensive mud flats."

The topographical details of the survey are thus reported:

Shore-line	$54\frac{1}{2}$ miles.
Area, (square miles)	$10\frac{1}{2}$

Mr. Rockwell assisted also in this work.

Topography of St. Helena sound, S. C.—This duty was commenced in the middle of February by the party of Assistant Seib. The weather was very unfavorable for field operations, and so continued until the 1st of March, when the party was transferred to another part of the section. The greater part of Hutchinson's island was surveyed, including the adjacent shores of Ashepoo river, and numerous water courses and branches traversing the island.

The plane-table work now reported completes the topography of that part of the northern side of the sound which lies west of Otter island. The statistics are as follows:

Shore-line surveyed	$50\frac{1}{2}$ miles.
Area, (square miles)	10

The subsequent operations of this party have been already mentioned. Assistant Seib, in his report, refers specially to the efficient and acceptable services rendered by Mr. Rockwell, who accompanied his party as aid.

The health of Mr. Seib not permitting him to take the field at the outset of the surveying season, the interval until the first of February was employed in inking the sheets of other parts of this section. Interruptions in the period of active operations were also thus occupied.

This topographical party was disbanded early in May, the schooner Graham being then laid up at Baltimore.

Assistant Seib afterwards resumed field duty in Section III, as has been mentioned in another place, but previously inked and turned in his plane-table sheets of Folly island and Morris' island.

Topography of Ossabaw sound, including the shores of the Ogeechee and Vernon rivers, Ga.—The preparation for this work was made early in the surveying season by Assistant A. M. Harrison, but the detention of his vessel for repairs at Norfolk, in consequence of damage received on her passage from the north in bad weather, delayed its commencement until the 31st of December. The results of the labors of his party between that date and the 15th of March are contained on two sheets, the limits of which are marked on Sketch No. 14. These include the complete topographical survey of the shores of Ossabaw sound and of the creeks flowing into it; the Great Ogeechee river and its tributaries from its mouth to Great Buzzard hammock; Little Ogeechee river, from its mouth westward, and its tributaries; Vernon river and its branches from the entrance to Possum island; the adjacent shores of the "Inland Passage," followed by steamers and small vessels through Ossabaw sound; and as boundaries of the sound itself—parts of Great Wassaw, Little Wassaw, Skiddaway, and Ossabaw islands. Raccoon Key, lying in the sound opposite to its entrance, and Green island, on the north side of the mouth of Vernon river, were also surveyed.

The part of Ossabaw island represented is the northern extremity from the ocean to the "Inland Passage," and from the sound shore two miles southward. On the north side of the entrance to Ossabaw sound the southern part of Great Wassaw island, to the extent of a mile northward, was included in the survey.

"The character of the country is such that in certain localities the topography could not be executed with the usual minuteness. In such cases careful sketching was resorted to with such checks as were found available. In some places the marsh was found exceedingly soft and unstable." "Other points are unapproachable at low-water on account of soft mud flats extending from the shore so as to prevent landing. Some of the work executed by myself and aids could be done only by going into the water waist deep. Sketching was confined to the less important parts of the survey."

"At the sources of creeks, where they usually divide and ramify through the marsh in innumerable small branches, forming islands and ditches, the ground is almost invariably soft."

"During the prevalence of heavy winds from seaward, the marshes are frequently overflowed, so as to admit the passage of boats over them. On Raccoon Key I observed sedge grass attached to the bark of trees three feet above the surface of the ground in the centre of the island. The water was driven from the sea to this height in the gale of 1854."

Other extracts from the report of Assistant Harrison, containing general descriptions of the localities surveyed, and remarks on the observed changes of shore-line, are given in Appendix No. 33. The statistics of the survey are thus stated in his report:

Shore-line surveyed	81	miles.
Shore-line of creeks	225½	"
Outline of marsh	76¾	"
Roads traced on sheets	19½	"

The topography is comprised within an area of about forty square miles.

Sub-Assistant Charles Ferguson was attached to the party of Mr. Harrison, and rendered efficient service. He was employed chiefly in the topography of the upper part of Ossabaw sound. Mr. W. H. Dennis, the aid of the party, was employed on both sheets, and also in office duty.

Assistant Harrison returned to the office early in April, and immediately proceeded to Section I, where he was joined by his party in the schooner Peirce, for continuing plane-table duty near Plymouth, as already described. At intervals in the progress of that work he inked and sent to the office his two sheets containing the topographical survey of Ossabaw sound and Ogeechee river and vicinity.

Topography of Sapelo sound and river, Ga.—The marginal details of this vicinity, beyond the shore-line which was traced last year, have been completed by the party of Assistant A. W. Longfellow. These consist of the filling in on the plane-table sheet, of the interior details of the lower part of St. Catharine's and the upper part of Blackbeard island, a part of Sapelo island, and the topographical features of cultivated ground, masses of wood, hammocks, marshes and creeks lying contiguous to the shores of Sapelo sound, and embraced between its several tributaries, known as South Newport; Barbour's, Julienton and Broro rivers, entering on its northern side, and Front, Back, and Mud rivers on the south. The detailed work, the limits of which are shown on Sketch No. 14, was carried above Sutherland's Bluff on Sapelo river. In my report of last year, the general character of the topography now referred to was described in extracts taken from the report of Assistant Longfellow. His work of the present season comprises one hundred and thirty-one and a half miles of shore line, and nearly twenty-two miles of road. The detailed work falls within an area of twenty-two square miles.

Assistant Longfellow was aided in the field by Mr. Clarence Fendall, and had the use of the schooner Meredith for transportation. The work at Sapelo sound was completed between the 12th of December and the 16th of February, when the party moved to Brunswick, Ga.

Points for hydrographic purposes were furnished in the progress of the plane-table survey to the party of Lieut. Comg. James H. Moore.

Field operations were considerably retarded in this locality by bad weather.

Topography of Brunswick harbor and Turtle river, Ga.—After completing the work last described, the party of Assistant A. W. Longfellow, in the schooner Meredith, resumed topographical duty at the city of Brunswick. In that vicinity the streets of the city, the roads connecting with them, the railroad, canal, cleared grounds and woods, and other surface features, not previously included on the sheets, were surveyed and mapped. The work of filling in was commenced on the 20th of February and continued until the 3d of April, and then embraced (Sketch No. 14) the details of the creeks and marshes connecting with Turtle river east and west of Brunswick, and the interior of Jekyl island, lying on the opposite side of St. Simon's sound. "The operations in the field were favored by an unusual exemption from the smoke and thick weather which generally prevails in the part of the season employed in this quarter."

A considerable proportion of the detailed work was executed by Sub-Assistant Clarence Fendall, then attached to the party as aid. One hundred and ten miles and a half of shore-line were determined, and seventeen and a half miles of roads. The work is upon two topographical sheets, and comprises Blythe island, with the site of the naval depot, surveyed last season, and Turtle river to the head of that island. The included area is about ten square miles.

The details of the southern end of St. Simon's island, which yet remain to be filled in, will be provided for early in the coming season if practicable.

The schooner Meredith returned to Portland in April, and was employed by Assistant Longfellow in prosecuting the plane-table survey of the vicinity of Portland, as stated under the head of Section I.

Hydrography of Cape Fear entrance and New inlet, N. C.—As a basis for comparison, and in order to investigate the causes of change in the capacity and direction of the channels into the Cape Fear river, the subject of which was referred to a commission at the opening of the year, a resurvey of both the main entrances was made by request and at the expense of the commission by Lieut. Comg. T. B. Huger, U. S. N., Assistant in the Coast Survey. At the main entrance close soundings were made to a distance of two miles outside from Fort Caswell and Bald Head Point, over the intervening shoals, and in the main ship and western bar channels. The soundings in the river were carried nearly two miles above Fort Caswell.

At New inlet the changes were determined by soundings made abreast of Federal Point, and continued outside from the light-house southward and westward to a point below Zeek's island, and thence across the bed of the river.

The shore-line necessary for the new hydrography was run in the course of the season, by Assistant C. P. Bolles.

The result of a preliminary comparison by Lieut. Comg. Huger, between his own and the survey made by Lieut. Comg. Maffitt in the winter of 1856, is given in Appendix No. 13. He states that no material change has occurred at Bald Head, or on the western bar; that the Pocket has undergone but little change, and that the middle ground remains about the same. Slight alterations were noticed in the Rip, with the same shifting tendency heretofore reported. Two spots with only six feet water were found on it by Lieut. Comg. Huger. He states that it has now a depth of seven feet at mean low water. Considerable changes were noticed in the shore line of Zeek's island, two openings having been made by the great gale of September, 1857. "Around the wharf the sand is making very rapidly, so much so, in fact, during the month I had the tide-gauge there, as to compel me to alter its location. Federal Point has changed but little, but the bulkhead, which threatened to close the entrance, has become broken and detached, particularly towards the northern end."

Lieut. Comg. Huger also states that the SW. spit of Zeek's island has been washed away, and that a large amount of material in that vicinity has shifted in position.

New Inlet bar seems to have suffered but little change since the survey of December, 1856.

The resurvey of the Cape Fear entrances was made between the beginning of May and the middle of June with the schooner Crawford.

Two hydrographic sheets containing the results were completed without delay and placed in the office. The aggregate statistics of work as derived therefrom are as follows:

Miles run in sounding	500
Angles determined	4,112
Number of soundings	25,623

Sketches No. 12 and 13 are comparative charts showing the result of the survey of this season and that first made in 1853.

Resurvey of Maffitt's channel.—In the middle of February a hydrographic re-examination of this important entrance to Charleston harbor was made by the party of Lieut. Comg. Huger. As compared with the capacity of the channel when last surveyed by Lieut. Comg. J. N. Maffitt, in June, 1857, the results show that the dredging operations of Captain Cullum, U. S. Engineers, have produced a steady improvement in the depth.

The bulkhead, separating the outer and inner curves of twelve feet water, which in 1852 had a breadth of over three thousand yards, is now reduced to less than eight hundred feet. In depth the channel has gained about eighteen inches since the survey of 1857, being now about ten feet and a half at mean low water. Lieut. Comg. Huger states that its width also and general character have decidedly improved. The substance of his report on the subject was communicated to the department in May, (Appendix No. 15.)

A synopsis of the statistics of soundings, made by the party in February last, is appended:

Miles run in sounding	126
Angles determined	602
Number of soundings	3,096

Before his separation from the Coast Survey, Lieut. Comg. Maffitt completed and turned in eleven hydrographic sheets, resulting from the labors of his party in this section in 1856–'57. No part of his work afloat is left unrepresented by a chart. He deposited at the same time the originals and duplicate notes of the soundings, angles, and tidal observations made at Cape Fear, Georgetown harbor, Bull's bay, Charleston harbor, in the North and South Edisto rivers, at Port Royal, and in St. Helena sound. The services of this officer have been acknowledged in another part of this report as of the most important character. His zeal, industry, and capacity have never been excelled, and have left his mark indelibly upon the hydrography of the coast.

Off-shore soundings from the coast of South Carolina and Georgia.—The hydrographic party assigned to this duty was placed, at the opening of the season, in charge of Lieut. Comg. T. B. Huger, U. S. N., assistant in the Coast Survey. The surveying schooner Crawford sailed with the party from Charleston on the 27th of February, and commenced work near Cape Roman. From thence southward to Amelia light, Fla., lines of soundings were carried broad off from the coast of South Carolina and Georgia, and terminated at varying distances, some going as far as a hundred miles from the land. Off the coast of Georgia several traverses were made, which occupied the party until the 17th of April, when the Crawford proceeded to Cape Fear and made the resurvey of the entrances, as stated under a previous head.

The off-shore work was resumed on the 14th of July. Additional lines were run south of Charleston, Amelia Island light being selected as the southern limit of the sheet which the soundings were intended to fill. The party continued the work until the close of July, and then proceeded to Norfolk.

The off-shore soundings executed by Lieut. Comg. Huger connect with the work commenced by Lieut. Comg. J. N. Maffitt, to whom, on his being detached from the work, the first named officer succeeded in the command of the hydrographic party.

In the early part of the season the weather proved boisterous, and baffling winds and currents interfered with the operations towards its close. The principal spaces yet to be filled by lines of off-shore soundings lie off Savannah and St. Simon's entrances, for the completion of which a party is about to sail under the charge of Lieut. Comg. J. P. Bankhead, U. S. N., assistant in the Coast Survey.

Sixty-seven specimens of bottom were taken in the soundings already made.

The following is a summary of the statistics :

Miles run in off-shore lines	1,470
Number of casts of the lead	1,434

The unfavorable weather of the season prevented the observations intended to be made on the ocean currents off the coast of this section.

Lieut. Comg. Huger notices, in his report, the highly satisfactory performance of the "Massey leads," which were used by his party in the Crawford.

The off-shore soundings of the season have been plotted, and the sheet containing them is now at the office.

Hydrography of Sapelo sound and river, Ga.—This work was commenced soon after the opening of the year by the party of Lieut. Comg. J. H. Moore, U. S. N., assistant in the Coast Survey. The entrance and Sapelo sound proper, with Sapelo river, as high up as Sutherland's Bluff, were included in the soundings. Points necessary for the work, and the requisite shore-line had been provided by the triangulation party of Lieut. A. W. Evans, U. S. A., and the topographical party of Assistant A. W. Longfellow. The hydrography in the vicinity of the bar yet remains to be executed. A summary accompanying the report of Lieut. Comg. Moore gives the statistics of soundings made between the 14th of January and the 5th of May, as follows:

Miles run in sounding	293
Angles observed	2,597
Number of soundings	37,732

Observations were made at two tidal stations for determining a plane of reference.

Lieut. Comg. Moore thus remarks on the character of the channel leading upwards into Sapelo river: "The entrance to the sound, and as far up as Dog island, affords a good beating channel of not less than four fathoms at dead low water. From that point up, the channel is very irregular and intricate; and on approaching Four Mile Point the depth shoals to two and a half fathoms at low water."

"Off the mouth of Broro river there is a bar which extends the whole way across to Creighton island. The deepest water on this bar at low tide is nine feet, and that depth does not give a channel of more than thirty metres in width. After passing the bar referred to, the water again deepens to three and a half and four fathoms, until within half a mile of Sutherland's Bluff, where the river becomes impassable for any but vessels of very light draught."

The schooner Wave, which had been used in the survey of Sapelo sound, returned to New York in May.

During the summer Lieut. Comg. Moore prosecuted the hydrography of the Sheepscot and Kennebec rivers, as stated under the head of Section I.

Arrangements are now in progress for the return of the party and completion of the soundings on Sapelo bar.

The office-work resulting from the hydrographic operations of Lieut. Comg. S. D. Trenchard at Brunswick harbor and St. Mary's river, Ga., was completed early in the year, under the direction of Lieut. F. A. Roe. All the original volumes containing the soundings, angles, and tidal notes have been deposited in the office, with duplicates, for future reference.

Tidal observations.—The self-registering tidal observations at the new custom-house wharf, at Charleston, S. C., under the charge of Mr. W. R. Herron, have continued to give very satisfactory results.

SECTION VI.

FROM ST. MARY'S RIVER TO ST. JOSEPH'S BAY, INCLUDING THE EASTERN AND PART OF THE WESTERN COAST OF FLORIDA, WITH THE REEFS AND KEYS.—(SKETCH F, Nos. 16 AND 17.)

Nine parties have been employed in this section—four in triangulation, three in topography, and two in hydrography. The triangulation parties worked throughout the season; the three topographical parties during a part, and two of them in dividing and marking the Florida keys for the General Land Office; one hydrographic party during the whole season, and the other merely incidentally, in passing from the Gulf of Mexico northward. The progress has been good, the two bases measured by myself in 1856 at Key Biscayne and Cape Sable having been connected, and the triangulation being continuous from Virginia Key (Cape Florida) to the Marquesas. There has not yet been time to determine whether this triangulation is all that is needed, but it is likely to be so if the air-line triangulation across the head of the peninsula is carried through, so that the connection between the Atlantic and Gulf work shall not depend upon the triangulation of the extensive coast of the peninsula and of the keys and reef. One more appropriation will, as I stated last year, suffice for the air-line triangulation, unless extraordinary claims for damages are made, which I do not now expect. In urging the appropriation of the whole sum estimated by the officer in charge of that work to be needed for its completion last year, I stated that if only ten thousand dollars were granted the same sum would be needed the next year to bring the work to a close. The air-line is across from Fernandina to Cedar keys, about one-sixth in length of the distance around the coast between the same points.

The triangulation of the main in Section VI would occupy four parties about four years. There will be that number at work this year, after which, for two years, say three parties, and then two, as the demands of the topography will begin to press close upon the appropriation after the present year, and at an increasing rate up to the fourth year. If means are furnished at this rate, and no extraordinary obstacles intervene, the triangulation will be completed in about seven years. To carry out this plan, however, requires all the resources which we have during the present year. In this section the topography will keep close to the triangulation, and the hydrography is comparatively of easy execution.

The survey is quite as far advanced as I had supposed, when making up my last report, that it would be. The Assistants showed good judgment in choosing the localities of work when the parties were interrupted by rumors of Indian hostilities. The details of progress will be stated under the following heads:

1. Air-line triangulation continued between Fernandina and Cedar Keys, Fla.
2. Triangulation of the eastern coast of the Florida peninsula, below St. John's river.
3. Triangulation of the Florida reef connected with the Cape Sable base.
4. Triangulation of Charlotte harbor, Fla.
5. Topography of the eastern coast of Florida, below St. John's river.
6. Topography of the Florida keys below Point Charles.
7. Topography of Key Largo and others in its vicinity.
8. Topography of Charlotte harbor, Fla.
9. Hydrography of the Florida reef, abreast of Key Vacas and Bahia Honda.
10. Deep-sea soundings between Key West and Havana.
11. Tidal observations at eight stations in the section.

Office-work.—A comparative chart of the entrance of St. John's river (1853 and 1857) $\frac{1}{10000}$, has been drawn, and the following have been in progress: two preliminary charts (Nos. 19 and 20) of the Florida reefs extending from Virginia key to the Tortugas, $\frac{1}{200000}$; three finished charts (Nos. 68, 69, and 70) of the Florida reefs extending from Virginia to New Found harbor keys, $\frac{1}{80000}$; and one of Key West and vicinity, (No. 72,) $\frac{1}{80000}$.

The engraving of the chart of Legaré anchorage has been completed; and progress has been made upon the preliminary chart No. 19, $\frac{1}{200000}$, from Key Biscayne to Key West.

Air-line triangulation between Fernandina and Cedar Keys, Fla.—This work was resumed on the 7th of December, by Captain J. H. Simpson, of the U. S. Topographical Engineers, Assistant in the Coast Survey, and has been prosecuted in accordance with the plan laid out in the reconnaissance made by that officer, the details of which were given in my last annual report.

In order to facilitate the operations required in advance of the complete angular measurements at stations along the line, Captain Simpson was joined at the outset of the season by Sub-Assistant J. A. Sullivan, and a detached party working under his charge was employed in opening lines of sight and erecting signals for observations. The work thus proceeded with the least delay possible until the 2[illegible]th of February, when Captain Simpson was detached from duty on the Coast Survey. The charge of the work was then assigned to Captain M. L. Smith, U. S. Topographical Engineers, the Assistant in charge of the office at Washington, whose intimate knowledge of the locality to be passed over in pushing the triangulation towards Cedar keys specially qualified him for that service. His arrival in the section was unavoidably delayed until the 29th of June. Sub-Assistant Sullivan, during the interval which elapsed after the departure of Captain Simpson, conducted the observations at established stations and directed the operations of the detached party then temporarily in charge of the aid, Mr. R. M. Stiles. The preliminary work on the opening of avenues and erection of signals was completed by the 10th of May. I visited this party in April, and was entirely satisfied with the progress made and with the plans proposed for the future.

The triangulation was resumed at a station about thirteen miles southwest from Fernandina, and has been carried thirty-one miles further in the direction of Cedar keys.

Observations were terminated for the season near the end of June at Padgett station, the position of which will be seen by reference to Sketch No. 16. Beyond this the reconnaissance has been made and lines opened for extending the work six miles further, to Trail Ridge.

The season in this part of the section was favorable for operations in the field. In opening avenues for the triangle sides or lines of sight, an aggregate length of a hundred and twenty miles required to be traced and cleared of intervening trees. The statistics of the triangulation given in the usual form are as follows:

Signals erected	7
Angles measured	22
Number of observations	973

The work of the season is embraced within an area of about two hundred square miles.

At the date of this report Captain Smith is about resuming active operations in the field.

Sub-Assistant Sullivan has been assigned to duty in the vicinity of Cape Cañaveral.

Immediately after being detached from duty on the work, Captain Simpson forwarded to the office duplicates of his record of horizontal angles measured last season in carrying the work southward and westward from Fernandina, descriptions of the signals observed on, and a journal of the occupation of the party while under his charge. Sub-Assistant Sullivan has completed and turned in corresponding data of the triangulation executed since the opening of the year.

Mr. F. W. Alexander was attached to this party as aid at the period of its reorganization, and resigned from the survey at the end of December.

Triangulation of the eastern coast of the Florida peninsula.—This work was begun on the 5th of December by Sub-Assistant Benjamin Huger, jr., at Mayport Mills, on the St. John's river. With but three exceptions the stations erected at the entrance for the triangulation of that river were found in good preservation, and these, with an additional station, served as a basis from which the triangulation of the coast was extended (Sketch No. 16) southward to Diego Plains. As the work advanced, computations were made for determining the positions occupied, the results of which, with other data necessary for the topography, were furnished to Mr. John Mechan, in charge of the plane-table party.

The field force of the triangulation party was weakened by general sickness amongst the hands employed. Mr. Rufus King, jr., the aid of the party, also suffered severely from illness.

The points determined lie within a belt of about two and a half miles in breadth, bounded on the east by the Atlantic coast line below the mouth of St. John's river.

Work was discontinued for the season on the 25th of May. Mr. Huger then discharged the party, and stored his camp equipage at Jacksonville.

The operations of the triangulation party were made very laborious by the necessity of opening lines of sight through heavy and thickly set woods. Nineteen signals in all were observed on. The usual statistics are thus stated in the report of Sub-Assistant Huger :

Stations occupied	14
Angles measured	46
Number of observations	1,079

This triangulation furnishes data for extending the plane-table work, about thirteen miles below the entrance of the St. John's.

Mr. Huger completed the computations of the field-work soon after his return to the office, and then resumed the secondary triangulation east of the Kennebec river, as stated under Section I. At present he is about completing preliminaries for continuing the triangulation down the eastern coast of Florida. His attention will be specially directed to the triangulation of St. Augustine harbor, the survey of which has been desired by the city authorities.

Triangulation of the Florida reef connected with the Cape Sable base.—The connection between the reef triangulation and the base line measured in 1855, by a party under my immediate direction, at the extremity of the peninsula, has been completed by the party of Lieut. A. H. Seward, U. S. A., Assistant in the Coast Survey. This was effected by signals on the keys lying southward and eastward of Cape Sable, and intermediate between it and Lignum Vitæ key. Connections were made on three lines of different triangles of the series carried in previous years down to the reef. From this junction the triangulation of the present season extends, as will be seen by Sketch No. 17, about twenty-five miles in a northwesterly direction, the last stations connecting with the termini of the base on Cape Sable. At the eastern end of the base a tripod and staging fifty-two feet in height, and a similar structure of forty feet elevation on Oyster key, were found necessary, in order to render those two points intervisible. Besides that just named, Sand key, Man-of-War Bush, Schooner Bank, and Rabbit key, were marked as stations, and included in the triangulation.

The stations occupied in previous years along the reef were also visited and generally found secure. In the requisite cases additional markings were made, and described in a record which has been placed in the archives.

The operations of Lieut. Seward commenced on the 20th of December, and were closed on the 15th of April. His party used the schooner John Torrey for transportation.

The angular measurements were made with the 10-inch Gambey theodolite, C. S. No. 15, and the detail of statistics is given in the season's report as follows:

Observing scaffolds erected	9
Stations erected	16
Objects observed on	24
Stations occupied	13
Series of observations	599
Number of single observations	3,592

Mr. C. B. Baker aided as heretofore in the work of this party.

The original journals, computations, and duplicates of the notes of horizontal angles measured by Lieut. Seward in the work connecting with Cape Sable, have been placed in the office, with descriptions of the signals used. He has deposited also like data of the triangulation of Barnes' Sound, and of that executed in the vicinity of Indian key. Reference to his subsequent field occupation has been made under Section II.

In the ensuing season the bases on Key Biscayne and Cape Sable will be connected, if practicable, by a series of triangles stretching along the main coast of the peninsula.

Triangulation of the approaches to Charlotte harbor, Florida.—Preliminaries for this work were commenced at Punta Rasa on the 13th of December by Lieut. J. C. Clark, U. S. A., Assistant in the Coast Survey. His party sailed from New York early in November, in the schooner Bowditch, but the vessel was obliged to put back with loss of sails, and sustained other damage, causing delay on her final passage to the south. The sum required for new sails, by lessening the amount allotted, also shortened the period of work, which, in consequence, was closed on the 1st of April.

The site for a preliminary base was selected by Lieut. Clark on the Gulf shore of Sanibel Island, lying at the southern entrance to Charlotte harbor. A line suitable in its connections was then cleared and measured, giving a length of 3,393.26 metres for the preliminary base. His report states that a site four miles in length and connecting with the western terminus could be cleared at little cost.

The triangulation extends from the entrance of San Carlos bay northward towards Charlotte harbor, (Sketch No. 16,) and was terminated for the season at stations between Boca Grande and Captiva Pass. An area of about a hundred square miles is embraced in the triangles. Twenty-two tripod signals were erected, and four of the ordinary kind, all of which were observed on. The number of stations occupied was nineteen, and eighty-one angles were measured by three thousand five hundred and twenty-eight observations with the 10-inch Gambey theodolite, C. S. No. 81, and 6-inch Brunner, C. S. No. 61.

Mr. C. W. Duval acted as aid to the party.

Lieutenant Clark commends the intelligent efforts of his Sailing Master, Mr. William Budd, who, in addition to his duties on the vessel, rendered acceptable assistance in the erection of signals and scaffolds for observing.

The work will be resumed during the present month by a party in charge of Lieut. W. R. Terrill, U. S. A., and under ordinary circumstances may be completed before the close of the next surveying season.

After his return in April, Lieut. Clark was engaged in the computations of his field-work. As incidental to it, but bearing more immediately upon developments to be made hereafter by the hydrographic party, he remarks in his report:

"The channel between Punta Rasa and Charlotte harbor is narrow and winding. After crossing the bar at the entrance of San Carlos bay, twelve feet can be carried to the bulkhead between Blind Pass and Captiva Pass. This deposit appears to be caused by the meeting of the flood tides which enter the two passes. It has about four feet on it at low and six feet at ordinary high water. The depth of water from the bulkhead to Captiva Pass is about seven feet."

Lieut. Clark was, at his own request, detached from the Survey in July last, previous to which he sent to the office his notes of the measurement of the preliminary base on Sanibel Island—a volume containing descriptions of the signals erected on the shores of Charlotte harbor, and duplicates of the record of horizontal angles. These were accompanied by his field computation of the results, in the usual form.

Topography of the eastern coast of Florida.—At a proper interval, after the commencement of the triangulation to extend southward along the coast from the entrance of St. John's river, the party of Mr. John Mechan was transferred from Section IV, and arrived in this locality at the end of January.

A junction was formed with the plane-table work of the St. John's, and from thence the topography was extended southward within the triangulation of Sub-Assistant B. Huger, jr., as far as Diego Plains, a distance of about eleven miles and three quarters from the place of beginning. East and west the resulting sheet represents the surface features between the Atlantic coast and the Pablo creek, a tract varying somewhat in breadth, but with an average of about two miles and a half. Both shores of that tributary of the St. John's, with its numerous windings within the space of ten miles, were also traced, as well as the line of the old military road running southward between it and the coast. The limits of this work are marked on sketch No. 16.

Field operations were discontinued on the 8th of May, at which time Mr. Mechan returned to the office and commenced inking his topographical sheet. The details traced upon it are thus given in his summary report:

Shore-line	13	miles.
Creek shores	40	"
Roads	27	"
Outline of marshes and fields	45½	"
Area surveyed, (square miles.)	26¼	

The following remarks are made by Mr. Mechan in reference to the region embraced by the work here noticed: "This portion of Florida is of diluvial formation, and generally a dead level, excepting where the hummock lands form slight undulations. Shell deposits occasionally occur. Three-fourths of the land is sandy, pine barren—of little value for farming purposes; but the hummock lands, being densely wooded with live oak, palmetto, &c., have in the lapse of time acquired a considerable vegetable deposit, and the soil being composed of mixed clay and sand, they make good arable land when properly cleared and cultivated."

Other extracts from the report of Mr. Mechan, of interest in this connection, are given in Appendix No. 34.

Topographical duty performed by his party at the outset of the surveying year has been mentioned under Section IV.

Immediately after returning north, Sub-Assistant Mechan inked and sent to the office the two sheets comprising his topographical survey southward from the entrance to St. John's river.

He was subsequently engaged in the reduction of plane-table sheets required in the office, but is now making arrangements for completing the topography below Cape Henry and north of Currituck Sound.

Topography of the Florida Keys.—The regular work in this quarter was resumed on the 22d of November by Mr. F. W. Dorr, who had been engaged until the close of the last surveying season in Section II.

Connecting at Point Charles with the previous work, he executed the topography of the inside shore of Long Island, extending as far as Tavernier creek, which separates it from Key Largo, and surveyed also several small shoals and keys lying in that immediate vicinity. The sheet containing them (Sketch No. 17) joins on the south with one executed at the same time by Sub-Assistant C. T. Iardella.

After completing the survey of Key Largo, Mr. Dorr moved his party in the schooner Dana, and from the southern limit of Mr. Iardella's survey at Long key, continued work down the line of keys to Key Vacas, meeting there the topography finished last year. On his two sheets of that locality are included the lower part of Long key, Conch keys, Duck key, the Channel keys, Tom's Harbor keys, Grassy key, the Crawl keys, and part of Fat Deer key.

All the fast land represented on both sheets was divided by quarter section posts, having their sides as usual marked by the letters M. MP or P., corresponding to the directions of meridians and parallels.

The statistics returned by Mr. Dorr are as follows:

Shore line	80¼	miles.
Area of sheet limits (square miles)	49	

Seventy-two wooden posts, designated as above, were inserted to mark the quarter sections.

Having, in conjunction with Mr. Iardella, completed the surveys of all the keys falling within the present limits of the triangulation, the party of Mr. Dorr was transferred to Charlotte harbor, on the Florida peninsula.

Mr. James Gilliss served with the party as aid in this section.

Two plane table sheets between those just described (Sketch No. 17,) were executed in the former part of the season by Sub-Assistant C. T. Iardella. These contain the keys and patches ranging along the main line from Key Largo southward and westward to Long key, severally known as Plantation or Windly's key, Vermont and Shell keys, another in their vicinity, Upper and Lower Matecumbe, three very small patches inside of the general line of keys, called Bowlegs, and the greater part of Long key, at the lower end of which his survey joined with that of Mr. Dorr, as already stated.

Most of the land forming the keys last named was found too unstable for marking in quarter sections. Plantation Key is frequently overflowed at high water, and several of the others are composed principally of deep mud. The fast land on Lower Matecumbe and Long keys was marked by twenty wooden posts, designated in the usual manner.

The plane-table statistics are as follows:

Shore line	$40\frac{1}{2}$ miles.
Area of keys surveyed (square miles)	8

The field work of this party was executed between the middle of November and the end of January. Mr. Iardella then sailed in the schooner Agassiz from Apalachicola, accompanied by his aid, Mr. J. S. Bradford.

My report to the Commissioner of the General Land Office, showing the recent progress made in the survey and marking of the Florida keys, was addressed to him in September. A copy of it will be found in the Appendix No. 35.

While engaged on the reef, Sub-Assistant Iardella furnished points for determining the position of soundings made by Lieut. Comg. W. G. Temple between Knight's key and Bahia Honda.

Topographical duty, subsequently performed by the party, will be mentioned under the head of Section VII.

Three plane-table sheets, containing the detailed survey of the keys first described, were inked by Sub-Assistant Dorr soon after his return from this section and filed in the archives.

In the course of the summer Sub-Assistant Iardella inked and turned in the two sheets last executed on the Florida keys, the limits of which have been already given. He is now about to resume field duty in prosecuting the survey of the keys lying in the vicinity of Cape Sable.

Topography of the Entrance to Charlotte Harbor, Florida.—This work was commenced in February by Mr. F. W. Dorr, with a party in the schooner Dana, after the completion of duty in a special locality on the Florida keys.

From points furnished by the triangulation party, Mr. Dorr traced in the shore-line of San Carlos bay, following the main coast from Punta Rasa, northwest as far as Sword Point and southeast beyond Mantanzas Pass, and including, on the eastern side of the bay, the entrance of Caloosahatchee river. The southern end of Pine Island and the eastern half of Sanibel Island, which form the western boundaries of the bay, are also embraced in this topographical survey. Sketch No. 16 shows the present limit of the work.

The usual plane-table statistics have been thus reported by Mr. Dorr:

Shore-line surveyed	113 miles.
Outline of woods	12 "
Area, (square miles)	76.

This party closed operations in the section at the end of March. The schooner Dana was then brought north and laid up at Baltimore.

Some of the characteristic features of land embraced by the plane-table work of Mr. Dorr are described in his report, and will be found in Appendix No. 36.

Mr. James Gilliss rendered efficient service as aid to the plane-table party.

The sheet comprising the survey made in the latter part of the season at San Carlos bay was inked by Sub-Assistant Dorr shortly after his return from the south, and is now in the office.

He then took the field in Section II, as stated under that head.

The *hydrographic records* of soundings, angles, and tides observed on the bar of St. John's river by the party of Lieut. Comg. Stephen D. Trenchard, U. S. N., were duplicated under the direction of Lieut. F. A. Roe, subsequent to the detachment of the first named officer, and just previous to his own separation from the Coast Survey. All the journals connected with work are now on file in the office.

Hydrography of the Florida reef.—Soundings on the outside of the main line of keys have been extended from the limits of last year, northward and eastward about ten miles, by the party in the surveying steamer Corwin, under the charge of Lieut. Comg. W. G. Temple, U. S. N., Assistant in the Coast Survey. He commenced on the 13th of January at the upper end of Bahia Honda, and carried the work outward about nine miles, (Sketch No. 17,) so as to conform to the general range of the hydrography previously executed by Lieut. Comg. Craven.

The eastern limit of his sheet coincides with a line drawn at right angles to the direction of the reef, and crossing Key Vacas. It contains the soundings made over an area of about ninety-four square miles. The hydrography was carried a little inside of Pigeon key, its range on the inner side of the keys being kept parallel with that outside. The soundings gave depths varying from two feet to forty-five fathoms. In connection with the hydrography, the rise and fall of the tides were observed in February at Knight's key.

Other particulars of the work are given as follows, in the official return :

Hydrographic positions used	1,254
Angles determined	3,605
Miles run in sounding	616
Number of soundings	19,591

While prosecuting this work the party was frequently hindered by rough weather.

Before leaving this section Lieut. Comg. Temple attempted a line of soundings in connection with temperature observations broad off from the reef. This was interrupted by the failure of the instruments, but so far as carried the results gave indications of a very gradual increase of depth, eighty-nine fathoms only being found in a position about nine miles from Indian key.

Lieut. Comg. Temple returned to New York early in April, and then engaged in office work. Mention has been made, under Section I, of the later occupation of his party afloat.

A chart of the work, executed by Lieut. Comg. T. A. Craven, U. S. N., Assistant Coast Survey, in 1856, between Eastern Sambo and Loggerhead Key, has been plotted within the year, and is now at the office.

Deep-sea soundings.—After ending a line of deep-sea soundings from the southwest pass of the Mississippi at the Tortugas banks, Commander B. F. Sands, U. S. N., Assistant in the Coast Survey, took advantage of good weather and a smooth sea to start a line across the Gulf Stream towards Havana, and another from thence to Key West.

The greatest depth, eight hundred and two fathoms, with a light cream colored clay bottom, was obtained within five miles of Moro Castle, at the entrance of the harbor of Havana. From the Tortugas to the coast of Cuba the water gradually deepened. The line from Havana to Key West showed a corresponding decrease in the depth; the darker cream colored bottom off the coast of Cuba changing again to white near the Florida reef. Soundings on this line were interrupted by a rough sea. On the two lines the depths and temperature at the surface, at 15, 50, and 100 fathoms, and at the bottom were successfully observed in fourteen positions. The lowest temperature obtained was 38 degrees, at a depth of 512 fathoms. The maximum surface temperature was 78 degrees.

Reference has been made, under Section IV, to soundings incidentally executed by Commander Sands on the southern passage of the steamer Walker. Further mention will be made, under Section VIII, of the deep-sea line carried from the Mississippi delta to the Tortugas, in which will be found also a notice of the general occupation of his hydrographic party.

Tidal observations.—At Fort Clinch, Fernandina, Florida, observations have been kept up by Mr. F. A. Rebarer during the season by means of one of Saxton's self-registering gauges.

Four tide gauges, established by Mr. G. Würdemann at Cape Florida, Indian Key, Key West, and Tortugas, were observed throughout a year. Three of the gauges were then transferred to Charlotte harbor, Tampa Bay, and Cedar Keys, to be observed for a like period, simultaneously with the one at Tortugas, which serves as a connecting link between the two series.

These observations were required to eliminate more completely the annual inequalities, the effect of which entered into the former comparisons of the tides in the Florida passage.

GULF STREAM.

Observations of much interest on the temperature and depth of the Gulf Stream within the Florida passage have been added this year by Commander B. F. Sands, U. S. N., Assistant in the Coast Survey, on a section from the Dry Tortugas to Havana. On his return from the season's work in the Gulf, in the Coast Survey steamer Walker, Commander Sands run a line of deep-sea soundings for depth and temperature across the Gulf from the mouth of the Mississippi to the Dry Tortugas, which was continued on the 8th and 9th of May across the Gulf Stream to Havana.

Soundings were obtained and specimens of the bottom brought up at nine positions between the Tortugas and Havana, giving sufficient data for the construction of a section of the bottom all the way across. The depth at each position was determined by Massey's indicator, the length of line paid out being also noted.

At position 2, seven miles from the Tortugas, the depth was thirty-five fathoms; at position 4, one hundred and six fathoms; at position 5, twenty-two miles from Tortugas, two hundred and ten fathoms; at position 6, three hundred and thirty-seven fathoms; position 7, fifty-four miles from Tortugas and forty miles from Havana, five hundred and twelve fathoms; and at position 9, five miles from Havana, eight hundred and two fathoms. At position 8, intermediate between positions 7 and 9, the indicator gave three hundred and twenty fathoms with nine hundred and eighty-five fathoms of line out, making the determination of this depth uncertain. In this instance it is probable that the catch on the indicator fell down at the depth of three hundred and twenty fathoms, thus stopping the revolutions of the register.

This section shows a remarkable falling off in the bottom from the Havana shore, the depth at the distance of five miles from Moro Castle being eight hundred and two fathoms, or a little less than a mile. The deepest cast in the straits of Florida, on the section from Florida to Bemini, obtained by Lieut. Comg. Craven, showed a depth no greater than three hundred and seventy fathoms.

The observations for temperature at different depths with Saxton's thermometer were very satisfactory at the depths at which they were taken; but an additional number of observations at each position would have given the distribution of temperature with the depth more satisfactorily.

The observations indicate a considerable degree of disturbance at the surface, and as deep, in some cases, as fifty fathoms, owing to the mixing of the overflowing cold water from the sides with the warm water of the stream.

The highest temperature observed at fifty fathoms was 78° Fahrenheit, and the lowest obtained was 38°, at the depth of eight hundred and two fathoms, at position 9, five miles from Havana.

On the line from the mouth of the Mississippi to the Tortugas, Commander Sands found the temperature at the bottom, at the depth of one thousand one hundred and thirty-three fathoms, to be 28° Fahrenheit. This position is in latitude 27° 16′ N., longitude 86° 57′ W.

The greatest depths reached on this line of soundings were one thousand eight hundred and six fathoms, in latitude 26° 52′ N., longitude 85° 39′ 30″ W., and one thousand seven hundred and ten fathoms, in latitude 27° 03′, longitude 85° 59′ 30″. In the latter case a specimen of the bottom was brought up. The depths were registered by Massey's indicator.

In 1853 Lieut. Comg. J. N. Maffit, in running the Cape Hatteras and Cape Fear sections, reported a counter current in each of the cold bands of the Gulf Stream. This phenomenon was again observed this year by Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast Survey, in his passage to New York from the Florida Reefs in the steamer Corwin. That officer noticed a SE. current, having a velocity of three knots an hour for twenty hours, in the first cold band beyond the axis of the Gulf Stream south of Cape Hatteras, and with reference to it he remarks:

"From noon of April 16th to noon of the 17th, as the vessel was in the middle of the stream and the wind was quite fresh from the SW., we confidently expected an unusually strong set to the NE.; but on the morning of the 17th observations taken for the longitude (with an interval of two hours) indicated that we were far to the southward of the reckoning, and the meridian observations confirmed that conclusion.

"It was observed that the vessel passed through a heavy 'tide-rip' about noon of the 16th, and that she again encountered a 'swash sea' at about 9 a. m. of the 17th, after which there was a considerable swell from the NE. I am, therefore, of the opinion that this extraordinary current was felt by us only for the space of twenty hours, which would give it a velocity of about three knots an hour. Of course it was altogether of a temporary character."

SECTION VII.

FROM ST. JOSEPH'S BAY TO MOBILE BAY, INCLUDING PART OF THE COAST OF FLORIDA, AND THE COAST OF ALABAMA.—(SKETCH G, No. 19.)

This is only the fourth year for which we have had an appropriation for this section of the coast, the progress previously made depending upon the employment of parties available from other sections for parts of the season. Nearly or quite one-third of the triangulation of the coast of the section is done; though, of course, it is yet impossible to say that this work is to be considered final, until it is carefully verified. It is plain, however, that with the same resources now at command, there will be a continuous triangulation of the coast of the section in less than eight years. These resources have enabled us to employ two triangulation parties during the whole season, and one from the next section during a part of it. The topography keeps up with the triangulation by employing one topographical party for each triangulation party. The hydrography is easy of execution on the outer coast generally, the bottom being regular, and depths increasing slowly in receding from the shore. A steam vessel was employed here last year, but being injured in a storm on the passage out, so much time was consumed in the repairs as to render it impossible to know whether the wants of this section and of section IX can be met by the use of the same vessel. I am inclined to think, however, that unless another hydrographic officer can be had, the work in the Gulf will lag behind what is desirable.

The discovery of a channel into the eastern end of St. George's sound, having twenty or twenty-one feet at low water in it, and leading to a safe anchorage behind Dog island, is one of the most valuable discoveries made in the Gulf. It affords a much more favorable access to Apalachicola than by the previously known passages. A particular description of the channel and anchorage, with sailing directions and remarks, is given in Appendix No. 16, from the report of Lieut. Comg. Duer, who has examined the locality. It is very desirable to know the cause which has produced this channel with a view to the probabilities of its permanence. Such observations as were made for the authorities of the State of New York would be very useful here, but they are beyond those which are required for purposes of navigation. They might readily be made for the State of Florida, by one of the parties, while carrying on regular work, if means were provided for the purpose.

The unchangeable character of the depth of Pensacola bar, established by a comparison between former surveys and that of Lieut. Comg. Duer, made last season, is of great importance. The depth now given of twenty-two feet and a half corresponds with that found by Colonel Kearney, U. S. Topographical Engineers, in 1822.

Office-work.—A map of Pensacola harbor, $\frac{1}{30000}$, has been drawn and engraved, and a chart of Apalachicola harbor has been engraved upon stone, under the direction of the Superintendent of Public Printing.

Triangulation southward from Crystal river, Fla.—On the 1st of December, 1857, the triangulation of the western coast of the Florida peninsula was resumed by the party of Sub-Assistant G. H. Bagwell. A proper connection was made on the line joining Half-Moon bar and Little island, (Sketch No. 19,) with the work extending from Cedar Keys, and from that point the triangulation was carried southward by a series of stations established on Crystal reef, Shell Point, Bear island, Bird key, Ragged island, and Homosassa Point, where operations were discontinued for the season on the 20th of March.

"The country over which the work extends consists chiefly of low boggy marsh, cut up with numerous shallow creeks and bays, and small keys covered with a thick growth of mangrove.

"The stations used were securely marked with iron screw piles, left four feet below and one foot above the surface of the ground.

"All the stations of previous years in the vicinity of Cedar Keys were examined in accordance with instructions. No marks could be found of the stations established on South Oyster reef and Snake key, but all the other points are well secured with granite blocks or screw piles."

During the winter the weather was generally unfavorable for work in the field. The triangulation executed comprises the following statistics:

Secondary stations occupied	7
Secondary stations established	5
Tertiary stations established	17
Observations made	1,836
Area of triangulation in square miles	50

The angles were determined by the eight-inch Gambey theodolite, C. S. No. 36.

Sub-Assistant Bagwell was aided in this section by Mr. M. O. Hering.

The party employed the schooner Joseph Henry, and furnished transportation for the topographical party of Mr. N. S. Finney, both working jointly as far as practicable. The broken character of the shores of this part of the Florida peninsula, however, renders it impossible for the plane-table party to keep pace with the triangulation, even when the operations of the former are confined to the essential details of shore-line.

At the close of the season the vessel returned north, and was laid up at Baltimore. Mr. Bagwell then took up the computations and revision of the results of the season's triangulation.

The joint parties are now on the way to resume operations in this quarter, the means available not admitting of their separate organization.

Triangulation of St. George's sound, Fla.—This work has been completed by the party of Sub-Assistant Spencer C. McCorkle. His operations within the present season carried the triangulation (Sketch No. 19) from the eastern end of St. James' island, over Alligator harbor and through St. George's sound, to a junction with his previous work at the line joining the western end of Dog island with a station at the mouth of Crooked river.

In the progress of the work points were furnished to the topographical party of Sub-Assistant C. T. Iardella, and land references necessary for the purposes of the hydrographic party of Lieut. Comg. J. K. Duer.

The field observations of Sub-Assistant McCorkle were made between the 21st of December and the 27th of March.

Twelve signals, in all, were erected, including those on Southwest Cape and the western end of Dog island.

"Before closing for the season all the stations used in the triangulation of the sound in previous years were visited, and found in a good state of preservation. The points are marked with care, and there can be no difficulty in finding them, even after the signals are gone."

The angular measurements were made with the six-inch Gambey theodolite, C. S. No. 55, at eleven stations. A compilation from the field records gives the following statistics:

Number of angles measured	40
Number of observations	1,152

An area of about seventy-five square miles is embraced within the limits of the work last executed.

In prosecuting the triangulation local difficulties were experienced peculiar to the eastern portion of St. George's sound. It was found impracticable to establish a signal on the shoal lying south of Alligator harbor; and, as instances of the tendency to changes by the action of the tidal current at that and other localities, Mr. McCorkle says: "On the shoal south of Alligator harbor the slightest resistance to the tidal current causes the sand to shift. The large bell-buoy which was placed on Oklokonee shoal has twice drifted from its moorings, and is now a total loss.

"On the highest part of Flag island a screw pile, fixed two and a half feet above ordinary tides, stands now, as I am informed, in three feet water, and is likely to be washed from its position.

"I found no less than three feet water on South shoal at low tide and a quicksand formation, so obviously insecure that the idea of fixing a signal there was abandoned."

As a basis for operations in the coming year Sub-Assistant McCorkle made a reconnaissance from St. Mark's, westward, and selected stations for connecting the triangulation of that harbor with the work at the eastern entrance of St. George's sound. The distance, in a direct line, is about twelve miles. When this connection is effected there will remain only an interval of eight miles between Ocilla river and St. Mark's, and another of about thirty-five miles, including St. Joseph's bay, to complete a stretch of continuous triangulation extending one hundred and fifty miles westward from Ocilla river entrance along the western coast of Florida. This is exclusive of detached work in other parts of the section.

Sub-Assistant McCorkle was aided in the field by Mr. A. W. Thompson.

The schooner Franklin was employed by the party for transportation, and at the close of the season was laid up at Apalachicola.

The records of horizontal angles connected with his work in St. George's and St. Vincent's sounds have been forwarded, in duplicate, by Sub-Assistant McCorkle and placed in the office. His computation of results for the lengths of triangle sides has also been received.

Astronomical observations at Pensacola, Fla.—It being desirable that additional observations should be made for latitude and azimuth, and for the determination of the magnetic elements at Pensacola, Assistant F. H. Gerdes, who has had the triangulation work in charge, selected a station in the public square for that purpose. The point chosen is nearly coincident with one of the stations used in the triangulation; and, in reference to its fitness for the use of the instruments necessary, Mr. Gerdes observes: "Although located in the midst of the city, the foundation of the station is perfectly solid. The square is a large grass plat, enclosed and undisturbed. In the latter part of April a small wooden shanty was erected containing stands for the transit instrument (C. S. No. 6) and zenith telescope (C. S. No. 9.) The eastern stand was exactly 24.14 feet from the flag-staff, bearing E. 3° 32′ N. Both instruments were mounted on the 1st of May, and observations were commenced by Sub-Assistant J. G. Oltmanns, who continued them on every clear night until the middle of June. During that period thirty-seven pairs of stars were observed for latitude. The whole number of observations recorded was a hundred and eighty-nine.

"For the measurement of an azimuth the station Plantation Hill was selected, and occupied by Mr. Oltmanns on the 16th and 17th of June with the twelve-inch Gambey theodolite (C. S.

No. 16.) He obtained four different sets of observations on the upper culmination of Polaris and the elongation mark, and referred the resulting angle to the triangulation."

The astronomical station point was secured by the insertion of a granite block, a full description of which has been furnished by Assistant Gerdes.

Magnetic observations.—On the 18th and 19th of June Sub-Assistant Oltmanns made sets of observations to determine the magnetic elements at the astronomical station in the public square at Pensacola.

These consisted of readings every fifteen minutes, during a period of eight hours, for the declination; two sets for inclination, and two for the magnetic intensity.

After the return of the triangulation party from this section Sub-Assistant Oltmanns computed his observations and placed the results in the office with the original records, and duplicates of the notes made in observing for latitude, azimuth, and the magnetic elements.

Assistant Gerdes has forwarded, with the field computations, the journal of latitude and azimuth observations made at Warrington in 1856.

Triangulation of Pensacola harbor and Escambia bay, Fla.—This work has been continued by the party of Assistant F. H. Gerdes, the operations of the season being prosecuted between the middle of February and the end of April, after the close of operations in Section VIII.

The triangulation then executed is in two localities—one at the western entrance of Pensacola bay, where five stations were established and lines observed on, connecting two points on the "Lagoon" with one on the main shore; and another selected near the western end of Santa Rosa island. Three of the stations were occupied. In the other quarter (Sketch No. 19) the triangulation was resumed at the dividing line between Pensacola and Escambia bays, and stations were erected and occupied on the shores of the latter as high up as Live Oak Point. At a few of these the observations were commenced in 1857. The angular measurements of the work on Escambia bay, extending upward about ten miles, are now complete to that distance, from the line joining it with Pensacola harbor.

"At Garçon Point a large tripod and scaffold were erected and used. From the line Garçon Point—Redfish Point the triangulation can be extended eastward, and from Punta Lora—Live Oak Point to the northward, so as to comprise the remaining upper part of Escambia bay."

The statistics of the season's work are thus given in the summary report of Assistant Gerdes:

Stations established	18
Stations occupied	10
Series of angular measurements	330

The area embraced in the triangulation is about fifty square miles.

In the next section mention will be made of the previous occupation of the party.

Computed results from the work just noticed, with a duplicate record of the horizontal angles measured in Pensacola harbor, have been furnished to the office.

Topography of Crystal bay and river, Fla.—Arrangements for continuing plane-table work on the western side of the Florida peninsula were made early in the surveying year by Mr. N. S. Finney, transportation for his party and instruments, as already stated, being furnished by Sub-Assistant Bagwell, in the schooner Joseph Henry.

The survey of the coast in this quarter was resumed on the 5th of December, a few miles north of the mouth of Crystal river, and from thence carried southward so as to include its shores, the outline of the main land forming the shores of Crystal bay and Salt Water bay, and numerous islands lying between the main and the offing. The complex system of shell and coral reefs bounding the western side of Crystal bay were also determined in position and traced on the plane-table sheet, the limits of which are defined on Sketch No. 19.

Mr. Finney assisted in the operations of the triangulation party in examining stations and erecting signals. The points necessary for his work were furnished by Sub-Assistant Bagwell.

On the 21st of March the topography had been extended southward to Mangrove Point, and was then closed for the season. The following is a summary of its details:

Shore-line surveyed	175 miles.
Area, (square miles)	46

Mr. Finney commends the activity and promptitude of Mr. J. L. Tilghman, who was attached to his party as aid.

The intricate nature of the shore-line of this part of the Gulf of Mexico makes it impracticable to keep an even range between the plane-table and triangulation parties when working jointly. Hence about eight miles of shore-line and several small wooded islands north of the Wethlocco-chee river entrance remain for survey in a future season. The topography will then be complete from above Cedar Keys to the mouth of Homosassa river.

Since his return from this section three topographical sheets have been turned in by Sub-Assistant Finney, one comprising his work in the vicinity of Waccasassa river and the others the results of his more recent survey of the coast between the Homosassa and Crystal rivers.

Topography of St. George's sound, Fla.—The party of Sub-Assistant C. T. Iardella, in the schooner Agassiz, arrived in this section on the 16th of February, having been previously employed on the Florida Keys. During its stay the shore-line and greater part of the interior of St. James' island were surveyed. The plane-table sheet represents a tract of fifteen miles in length by nearly three in breadth, (Sketch No. 19,) forming the northern shore of the principal eastern outlet of St. George's sound. Its western limit joins with the plane-table work of Assistant G. D. Wise.

Some of the details of that part of St. James' island lying adjacent to Crooked river, which separates it from the main body of the peninsula, yet remain to be filled in.

"The island is over twenty miles in length by three in breadth. Its surface is thickly covered with yellow pine, an undergrowth of oak and palmetto trees. The soil is generally a sandy loam, but in some parts the land is good.

"Numerous ponds of water, varying in depth from six to forty feet, occur in several places on the island."

The following summary of statistics is extracted from Mr. Iardella's report:

Shore-line surveyed	55	miles.
Outline of marsh and ponds	26	"
Roads	5	"
Area, (square miles)	27	

Mr. J. S. Bradford accompanied the topographical party as aid.

Field operations on St. James' island were closed in the middle of April. The schooner Agassiz was then despatched north and laid up at Baltimore.

While engaged on the shores of St. George's sound, one of the men belonging to the party was severely wounded. The necessary operations of amputation and general treatment were performed by Dr. McClellan, of the army, to whose special courtesy and kindness Sub-Assistant Iardella particularly refers as deserving of the warmest thanks.

Assistant G. D. Wise resumed duty early in the surveying season, and joining with the sheet which has been just described, executed the remaining topography of the main shore of St. George's Sound and Apalachicola bay. Dog island and St. Vincent's island were also surveyed, and the work of the season connected with that done by him last year eastward and westward of Apalachicola. From the western limit of last season the topography of the main was extended to a point beyond Indian Pass, in the direction of Cape St. Blas.

Mr. Wise co-operated with Sub-Assistant Iardella in tracing the shore-line of Alligator harbor, the details of which appear on the sheet of St. James' island, before referred to, and also assisted the hydrographic party while at work, by indicating the position of points determined for regulating the soundings, and furnishing shore-line.

Two plane-table sheets contain the results of the present season. These represent (Sketch No. 19) a hundred and forty miles of shore-line within an area of about fifty square miles.

The topographical work on this part of the coast of Florida, is now complete from Ocilla river to the western extremity of St. Andrews' bay, with the exception of twenty miles of coast east and west of St. Mark's harbor, and the shore in the vicinity of Cape St. Blas and St. Joseph's bay. Two or three ordinary working seasons will suffice for completing the survey within the limits stated.

Assistant Wise employed the surveying schooner Howell Cobb for transporting his instruments and the camp equipage used by his party. His operations in this section were closed early in March. The party was then discharged, and the vessel laid up securely in Apalachicola river.

Mr. Wise was aided in the field by Mr. F. F. Nes.

On his return to the north Assistant Wise was engaged in office-work, and in the course of the summer completed and turned in the concluding sheets of his survey of the shores of St. George's sound.

Tracings of the shore-line were at once made and furnished to Lieut. Comg. Duer, for the completion of his charts of the passes and channels into the sound.

Topography of Pensacola and Escambia bays, Fla.—Under the direction of Assistant F. H. Gerdes, who was employed in the work of triangulation, the plane-table survey has been extended on the western side of the entrance to Pensacola bay, so as to embrace the main and interior shores of the "Lagoon" for a distance of about four miles westward from Fort McRae. This work was executed by Mr. C. H. Boyd, attached as aid to the party of Mr. Gerdes. On a second sheet Mr. Boyd included the characteristic topography of the eastern shore of Escambia bay, from Garçon Point to Live Oak Point, and the details of the western shore from Punta Lora to Emanuel Point, (Sketch No. 19,) where the plane-table work of the season joins with that of Pensacola bay, executed by Assistant Gerdes in 1856. A portion, extending about three miles westward of Redfish Point, of the tract known as Live Oak Plantation, is also included on the same sheet. These details served to fill out the project which had been adopted for the preliminary chart of Pensacola harbor and its approaches.

The following synopsis of statistics is taken from the report of Assistant Gerdes:

Shore-line surveyed	38 miles.
Area of topography, (square miles)	21

Further mention will be made of the operations of the party under the next Section.

On his return to the office Mr. Boyd was detailed for duty in Section I.

The plane-table sheet of part of Pensacola bay last executed has been inked, and is now in the office, as also the sheet containing the details of the survey of the lagoon lying at the west side of the entrance.

Reconnaissance of a new channel into St. George's sound, Fla.—While conducting the regular hydrography of the passes of St. George's sound, reference to which will be made presently, Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey, received intelligence from Sub-Assistant Spencer C. McCorkle which led to the discovery and development of a new channel or pass, leading near the eastern end of Dog island into the sound. In reporting upon it, after making the requisite preliminary soundings, Lieut. Comg. Duer says: "The fact is established that an excellent channel exists from sea to the sound, (St. George's,) running close in with the north shore of Dog island, with not less than twenty-one or twenty-two feet of water, (twenty or twenty-one feet at low water.)"

The following statistics show the details of the preliminary examination:

Angles determined	60
Miles run in sounding	100
Number of soundings made	3,500

Full sailing directions for entering St. George's sound by this pass were prepared without delay, and, on being furnished by Lieut. Comg. Duer, were communicated to the department. Extracts from his report, then published in the usual form, for the information of navigators, will be found in Appendix No. 16, together with his recommendations in regard to buoys and additional lights for the new channel.

The party in the steamer Vixen being also under orders for work in Section IX, the inside hydrography of St. George's sound, except in the immediate vicinity of the passes, was necessarily deferred till the coming season. Late in May the vessel proceeded to Galveston.

The regular work of the party in this section will be now referred to.

Hydrography of the East Pass, St. George's sound, Fla.—The party assigned to this duty, in charge of Lieut. Comg. Duer, was organized at the outset of the season, and left New York with the surveying steamer Vixen at the usual period for resuming work at the south. On her downward passage the vessel was seriously damaged in a violent storm, and the commencement of operations in St. George's sound was in consequence delayed until the beginning of March.

After executing the requisite soundings in another locality the hydrography of the East Pass and its approaches was taken up on the 6th of April and prosecuted to completion by the 10th of May.

The space included in soundings stretches abreast of the western end of Dog island, and from thence westward and southward past the eastern end of St. George's island.

The East Pass, intervening between the two islands mentioned, was closely sounded out, together with the approaches from the Gulf, ranging outside about six miles. Inside the work was carried quite across the breadth of the sound, and throughout an extent of about seven miles of its length in that vicinity.

The shore-line necessary for the hydrographic operations was furnished by Assistant George D. Wise.

Lieut. Comg. Duer returns the following as a summary of statistics derived from the journals and sounding books:

Angles determined	1,023
Miles run in sounding	489
Whole number of soundings	26,390

The tides were observed while the work was in progress for the adjustment of soundings on the chart.

A shoal lying outside of the west breakers of the East Pass, and near the eastern point of St. George's island, was determined in position by Lieut. Comg. Duer. The particulars in regard to it have been communicated to the department, and are given in Appendix No. 17.

Following in geographical order, the work executed earlier in the season by the party in the steamer Vixen will be next noticed.

Hydrography of the West Pass, St. George's sound, Fla.—This work was commenced by the party of Lieut. Comg. Duer on the 2d of March, and was completed on the 30th of that month. It comprises the soundings of the approaches, entrance, and channel of the West Pass between St. George's and St. Vincent's islands and the adjacent part of St. George's sound up to the anchorage off Apalachicola. The shoal off Cape St. George, usually known as the "Cape Shoal," was also thoroughly surveyed.

At the approaches the soundings were carried about six miles into the Gulf. The following synopsis of statistics is taken from the general report made at the close of the season by Lieut. Comg. Duer:

Angles determined	972
Miles run in sounding	510
Whole number of soundings	26,570

Tidal observations were made by the hydrographic party at five stations on the shores of St. George's and St. Vincent's islands in the immediate vicinity of the West Pass.

While employed in the soundings, Lieut. Comg. Duer developed a new channel for entering St. George's sound between the two islands last named, and promptly furnished sailing directions therefor. These were communicated to the department early in May, together with extracts from his preliminary report, stating the character of the "Cape Shoal" and of another, with only nine feet water, occurring near mid channel, and just inside of the bar of the West Pass. The least water found in the channel referred to was seventeen feet. The details in regard to it and the shoals are stated at length in Appendix Nos. 17 and 49.

Mention has already been made of the subsequent labors of the hydrographic party in the survey of the East Pass.

The hydrographic sheets of both these passes have been placed in the office, with the journals of soundings and angles, and records of the tidal observations made in the course of the work.

Tidal observations.—A self-registering gauge has been established at Pensacola, Fla., and left in charge of S. Thayer Abert, esq., engineer of the navy yard, who has kindly undertaken to furnish the record of its operations.

SECTION VIII.

FROM MOBILE BAY TO VERMILION BAY, INCLUDING THE COAST OF MISSISSIPPI AND PART OF LOUISIANA.—(SKETCH H, No. 22.)

The usual number of parties has been employed in this section, but the hydrographic party was delayed in reaching the ground of work by the exigencies of the naval service, which prevented the assignment of officers at the time they were needed.

The following operations have been executed during the season:

1. Telegraphic determination of the differences of longitude between Mobile and New Orleans; and observations at the last named city for latitude and the magnetic elements.
2. Triangulation of Lake Pontchartrain, and connection made with stations in New Orleans.
3. Observations at the Mississippi delta for latitude and azimuth.
4. Measurement of a preliminary base, and triangulation of the passes of the Mississippi delta.
5. Reconnaissance for extending the triangulation from Côte Blanche bay, La., westward into Vermilion bay.
6. Topography of the district between Lake Borgne and Lake Ponchartrain.
7. Hydrographic reconnaissance in the southwestern part of Lake Borgne.
8. Hydrography of part of Atchafalaya bay, Louisiana.
9. Deep sea soundings in the Gulf of Mexico, between the Mississippi delta and Key West.

The deep soundings, taken by Commander Sands, U. S. N., in this and previous seasons, prove that the warm water of the Gulf, at least of the part between Key West and the Belize, and therefore probably of the whole, is underlaid by cold water at no very great depth. These observations, though made incidentally, are of great interest to scientific men.

The remarks made in my report of last year, in regard to the progress to be expected in this section, and the wants of the survey there, do not seem to require additions at present, as they anticipated correctly the condition of the work.

Office-work.—The following drawings of this section have been continued; preliminary chart (No. 26) of the coast of Mississippi and Louisiana, from Mobile bay to Lake Pontchartrain, $\frac{1}{200000}$; and Mississippi sound, (No. 92,) from Round island to Grand island, $\frac{1}{80000}$. A finished map, (No. 93,) of Mississippi sound from Grand island to Lake Pontchartrain, inclusive, $\frac{1}{80000}$, has been commenced.

Progress has been made in the engraving of coast chart No. 91, $\frac{1}{80000}$, from Bon Secour bay to Round island; coast chart No. 92, $\frac{1}{80000}$, from Round island to Grand island; preliminary chart No. 26, $\frac{1}{200000}$, from Mobile bay to Lake Pontchartrain; and on the plate of Biloxi bay. The preliminary charts of Mississippi City harbor, St. Louis bay and Shieldsboro harbor, and Grand island pass, have been engraved upon stone, under the direction of the Superintendent of Public Printing.

Astronomical observations for telegraphic difference of longitude between Mobile and New Orleans.—The longitude of Mobile having been satisfactorily established last season, by the use of the telegraph, Assistant George W. Dean was directed to organize the parties necessary for completing the chain of telegraphic differences of longitude from Washington to New Orleans.

On the 14th of December the astronomical instruments and telegraph apparatus were forwarded in charge of his aid, Mr. A. T. Mosman, by steamer from New York to New Orleans.

Sub-Assistant Edward Goodfellow, with Mr. Julius Kincheloe as aid, was assigned to the charge of the party at New Orleans, Mr. Dean meanwhile taking charge at Mobile, and directing the operations at both stations.

The telegraph lines between the two cities were kindly placed at the disposal of the Coast Survey, after the regular business hours, (10 p. m.,) by John Kendall, esq., general superintendent of the Magnetic Telegraph Company's lines between New York and New Orleans.

The numerous small rivers west of Mobile, subject to frequent freshets during the winter months, and the swampy character of the country over which the telegraph lines to New Orleans are of necessity located, made the successful accomplishment of this work unusually difficult.

At Mobile five hundred and twenty-three observations were taken upon eighty-four stars, for ascertaining the local time and for instrumental corrections. For the determination of the thread intervals of the C. S. transit No. 8, sixty-five observations were made upon fifteen circumpolar stars, and nearly two hundred stars were observed for longitude by the electro-magnetic (American) method, in connection with the station at New Orleans.

Sub-Assistant Goodfellow had previously determined the latitude and magnetic elements at the astronomical station in Mobile.

The usual meteorological observations were also made there and recorded by Mr. Kincheloe.

At New Orleans, notwithstanding the precaution taken in selecting sites for the granite piers upon which the astronomical clock, transit, and zenith instrument were placed, it was soon apparent that the clock rate was seriously affected by the passage of carriages over the unpaved streets in the immediate vicinity of the station. In order to avoid the error which would be occasioned by such disturbances, its rate was deduced from a series of observations made in the early part of the evening, and again near the close, the rate being relied on only for the few hours during which the clock was entirely free from outside vibration.

Assistant Dean made six hundred and fifty observations upon ninety zenith and circumpolar stars, for determining the local time, thread intervals, and instrumental corrections, and two hundred and fifty stars were observed by the electro-magnetic method for difference of longitude as referred to the Mobile station.

In the course of the season one hundred observations were made on three nights for the personal equation between Messrs. Dean and Goodfellow. The inequality of the pivots of the transit instruments were from time to time ascertained by series of careful levelings.

Mr. Dean makes special mention in his report of the facilities which were extended for the work at New Orleans by Colonel Tanner, local superintendent of the Mobile telegraph lines, and by Mr. Trabue, superintendent of the National lines.

The longitude operations were closed for the season on the 10th of April, the parties being then transferred to Section II.

Latitude observations at New Orleans.—During the progress of the operations last detailed Sub-Assistant Edward Goodfellow made two hundred and sixty-three observations upon forty-four sets of stars for the latitude of the astronomical station used at New Orleans. The micrometer divisions of the instrument employed (zenith telescope, C. S. No. 5) were determined by three complete series of observations upon Polaris, near its western elongation. The divisions of the level scale were measured with the micrometer in the usual manner.

In these duties Sub-Assistant Goodfellow was aided by Mr. J. Kincheloe.

Magnetic observations.—At intervals of the period occupied by Assistant George W. Dean in longitude observations at New Orleans, the magnetic elements were determined by him in the public square near the site of the astronomical station. One hundred observations were made for declination; two sets of experiments for horizontal intensity; and two sets for moment of inertia, with the magnetic declinometer, C. S. No. 1. The dip of the needle was ascertained from two series of observations with the ten-inch dip-circle, C. S. No. 4.

At the special request of the New Orleans Academy of Science, Mr. Dean established and marked with heavy granite posts, which were furnished by that institution, a meridian line extending from the north side of Canal street to the east side of the public square on Basin street, a distance of three hundred and forty-one feet. The astronomical observations necessary in determining the line were made with the forty-six inch transit, C. S. No. 6, and the ends were marked by needle-drill holes in copper bolts inserted in the tops of the granite posts.

As this line was carefully marked it may be of much service to local engineers and surveyors.

At New Orleans the usual meteorological journal was kept, in which two hundred and ninety observations of the barometer and thermometers were recorded by Mr. A. T. Mosman.

The subsequent occupation of the parties has been described under Sections I and II.

A duplicate of the record of magnetic observations made at New Orleans was completed early in the summer by Assistant Dean, and forwarded to the office. Sub-Assistant Goodfellow has furnished in duplicate the records of similar observations at Mobile, and those of the latitude observations made at New Orleans, together with his computation of the result, and a list of the places of stars used in the determination.

Triangulation of Lake Pontchartrain and the vicinity of New Orleans.—Sub-Assistant Stephen Harris has executed the work necessary to complete the main series of triangles from Rigolet light to New Orleans, determining, at the same time, additional points for the topographical survey, and has extended the triangulation so as to include the longitude station and a number of prominent points in the city of New Orleans, and to furnish a base for the continuation of the work down the Mississippi river, (Sketch No. 22.)

The destruction by fire of the station at the lake end of the Pontchartrain railroad, before the angles from Little Woods and the Marine Hospital could be observed upon it, still leaves the series with but two angles measured in several triangles. The station was located on the roof of a house, in the burning of which all marks of reference were destroyed.

Sub-Assistant Harris was aided in the field-work by Mr. R. E. Halter and Mr. Henry W. Bache. The computations were made by Mr. Halter, who also observed some of the angles.

The instruments used in the observations were the ten-inch repeating theodolite, No. 79, and the six-inch repeating theodolite, No. 84.

The following return of statistics is made in the season's report:

Number of stations occupied	12
Number of stations determined	24
Number of angles measured	102
Number of observations, sets of six repetitions	496
Area of the triangulation in square miles	158

The party took the field about the first of December, and closed about the beginning of June. Mr. Harris soon after proceeded to Section I, under which head his operations on the Penobscot have been already mentioned.

The schooner Twilight was used by the party for transportation.

The new light-house on St. Joseph's island, in Lake Borgne, was determined in position, and the angle at Cat Island station, between Ship Island light and Chandeleur light, was measured to strengthen the determination of the latter. These observations were made at night upon the dioptric lights, which showed to great advantage.

The party also visited and secured the stations on Chandeleur sound, which will be required for the continuation of the work in that locality.

Latitude, azimuth, and time observations at the Mississippi delta, La.—The station selected last year by Assistant F. H. Gerdes was properly prepared for astronomical work early in the season, Sub-Assistant J. G. Oltmanns having been detailed to make the requisite observations.

The station is the foundation of the old light-house at the head of the Passes, which has been ceded to the Coast Survey by Mr. John King, of New Orleans. Its location is at the point between the South and Southwest Passes, a short distance below the southern end of the preliminary base, a description of which will be given elsewhere. The foundation referred to consists, underground, of a solid circle of brick masonry, which rises four feet above the surface at an angle of forty-five degrees. Its diameter at the base is twenty-four feet, and eighteen feet at the top. The masonry itself is said to rest upon several rows of piles. An iron bolt inserted near the centre of the structure designates the *station*, over which a brick pillar, two feet square by two and a half feet in height, was built as a stand for the transit and zenith telescope. The instruments were protected by a simple structure of wood.

"On the 24th of December the C. S. transit No. 6 (by Würdemann) was mounted and adjusted to the meridian by Sub-Assistant Oltmanns. During the seven successive nights following seventy-two transits of stars were observed for local time and chronometer rate. The zenith telescope (Würdemann) C. S. No. 9 was then set up, and observations were made for latitude until the 25th of January. For these twenty-nine pairs of stars were used, selected from the B. A. catalogue. The number of observations on all amounted to one hundred and sixty. For determining the value of the micrometer three sets of observations were made on Polaris at its western elongation."

"After the first of February the rate and error of the chronometer (Hutton, sidereal, 220) were verified and the twelve-inch Gambey theodolite (C. S. No. 16) mounted and used for the measurement of an azimuth. The angle obtained between Polaris, at western elongation, and the elongation mark (about two miles and a half distant, on the eastern border of the river) was transferred to one of the primary stations of the triangulation. Eight different azimuths were observed, and all coincide very well among themselves."

"In the early part of February a number of transit observations were made for local time. On the 29th of January, and on the 3d and 8th of the succeeding month, telegraphic signals were exchanged with the party in charge of Assistant G. W. Dean at the magnetic observatory in New Orleans, giving an approximate longitude for the station at the delta."

Assistant Gerdes has forwarded to the office the original notes of the astronomical observations, with the observer's computation of latitude, and lists of the places of stars used for transits and in the exchange of telegraph signals.

The next duty performed by the party in this section was the measurement of a preliminary base.

Preliminary base at the Mississippi delta.—The site for this base was selected in the spring of 1857 by Assistant F. H. Gerdes, and the reconnaissance of the vicinity, preliminaiy chaining, and topographical survey, were made at the same time. The line runs along the eastern bank of the Mississippi from a point just above the junction of the passes, (sketch No. 22,) at the distance of from twenty to fifty metres from the water margin in summer. It is about four miles in length, and its direction is northward and westward from the lower terminus abreast of the old light-house, which has been established as the astronomical station.

The land is low and level, and in periods of freshet or during high tides is subject to overflow. In summer and fall it is represented as being very dry and firm, but in the winter and spring, particularly after heavy rains, the surface becomes soft and sticky. At the distance of a few hundred yards from the south end of the line the ground assumes a marshy character. The site ranges along a very narrow strip of land which divides the main bed of the Mississippi from *Bay Rondo*, a navigable sheet of water between Bird island and the Pass á Loutre marshes.

Assistant Gerdes reports that "during the summer of 1857 the bay shore had been washing slightly, and for that reason the site was altered in the fall by shifting the northern terminus about twenty feet towards the river. The intermediate point near Cubitt's house remaining as before, the southern end of the line was thus brought about six or seven feet further from the margin of the water."

"After the line had been accurately staked out the measurement was commenced on the 21st of November, the bars provided with contact slides, and the improved trestle designed by Assistant J. E. Hilgard being used in the operation."

Assistant Gerdes continues: "I commenced at the station *Cubitt's*, about three-quarters of a mile above the south end, and followed up to the northern terminus. This was done from necessity, as it could not be determined how far down the southern extremity of the line should fall, so as to be visible from Robinson's Point. The erection of a tripod was attempted, but no boat with the required lumber could pass through the canal, and the operations on the southern portion of the base were in consequence deferred for that time."

"The measurement of the line from Cubitt's signal to the north end was completed on the 1st of December, seven days being occupied in the determination with the bars. Two days intervening between the dates mentioned were employed in clearing the site of reeds and cutting out drift logs."

"The apparatus was transferred to the southern portion and the measurement resumed at Cubitt's on the 7th of December. In consequence of a dense fog, the operation was suspended temporarily, but was recommenced and completed on the following day."

Assistant Gerdes found the aggregate length of the two lines to be 5918.83 metres, and the separate lengths of the north and south parts corrected for temperature 4998.5258 metres and 920.1624 metres respectively, giving for the total reduced length 5918.69 metres.

"From Cubitt's to the northern end the ground was found generally firm, and with stability sufficient to insure accuracy in setting the trestles. At one or two places the soil appeared slightly tremulous and rather wet, and greater despatch was used in passing over them."

"The elevating and depressing slides on the trestles, which at my suggestion had been fitted with metallic friction rollers, gave great satisfaction in working."

While the measurement was in progress the party of Mr. Gerdes erected tripods ranging over thirty feet in height at Robinson's Point, at the head of the Southeast Pass, and at the south terminus of the base. The ground in the vicinity of the lower part of the line is level and solid.

"Mr. R. E. Halter made the alignments necessary in the measurement with the C. S. theodolite No. 87. The posts used in marking were inserted deep in the soil, the exact points on them being defined by cross lines cut on the heads of copper nails."

Mr. C. H. Boyd was attached as aid to the party of Assistant Gerdes.

After completing operations connected with the preliminary base, the triangulation of the delta was resumed from the former limits. Special reference will be made to that work hereafter.

A duplicate of the record kept during the measurement of the base, and the field computation deduced therefrom, have been filed in the office with other data of the same kind.

Triangulation of the Mississippi delta, La.—From the site of the base line at the junction of the passes, a description of which has just been given, Assistant Gerdes continued the triangulation of the delta on the plan laid out last year. It now embraces the Southeast Pass and the South Pass, (Sketch No. 22,) and includes also a considerable part of the district traversed by the Southwest Pass. Some of the stations of the previous season were re-occupied. The scheme, as worked on, divides the whole of the area of the delta into triangles of the second and third order, and good advance has been made in the determination of the signals already erected, considering the high stage of water in the river while the party was employed there, (the highest known within a period of twenty years.) Early and frequently recurring fogs also retarded the progress of the triangulation.

"All the marshes were inundated, and if sometimes relieved it was only for a few hours during the spring ebb tides. The ground consequently had become too unstable for the use of the tripods and scaffolds, and the time and care required in making observations were thus doubled."

"At the principal stations tripods of from thirty to thirty-five feet in height were erected. These were furnished with scaffolds built entirely free from the structures. The other stations consist of tall signal poles inserted into screw piles and braced by wires."

"A sweeping northern storm on the 23d of December prostrated all the signals which had been put up; and most of those restored were again blown down in a hurricane on the 15th of January."

The schooner Gerdes, used by the party for transportation, was driven ashore by the last mentioned storm, but was finally got off with the loss of an anchor and cable, which had got foul in the grounded logs of the river.

The position of the base, being midway in the scheme of triangles as it ascends upwards from the passes, is very favorable for securing the greatest accuracy in the work. Beyond the site of the base the reconnaissance is made and signals erected for completing the triangulation upwards to Fort St. Philip.

The statistics of the work, as far as executed, are as follows:

Stations established	36
Stations occupied	13
Secondary triangles determined	16
Tertiary triangles determined	19
Series of observations	800

The astronomical station was connected with the triangulation.

Assistant Gerdes remarks, in reference to the general character of the tract over which his work extends and the peculiar circumstances under which it was prosecuted: "The soil consists of soft clay and mud, overgrown sparingly with tall reeds, but, under ordinary circumstances and at a low stage of the river, spots may be found close to the shores that will afford steadiness sufficient for observing. In the present season, however, between December and May, the whole of the delta has been inundated, and under some of the tripods which had been previously erected I found several feet of water. No spot was left dry, and frequently planks were required to prevent us from sinking beyond the reach of recovery. The tripods were, therefore, of necessity inserted deep and based on broad foundations of boards, their legs being disconnected by deep ditches from those of the scaffolds."

"In the summer and fall, however, the ground is quite hard, and observations with light instruments may be made with safety, provided that the scaffolds are kept detached from the roots of the tripods."

"The only stations which admitted of observations from the ground were Bird island, the astronomical station at the old light-house, and a few of the mud banks at the mouths of the easterly passes. These mud islands seem to be imbedded in large fields of softer mud, and the idea that they are movable gains strength from the fact that when holes are dug in them streams of soft mud will sometimes spout up for several feet. At any rate, the mud islands appear suddenly, remain sometimes for years, but occasionally disappear entirely in a very short time." * * * * * * * * *

"Springs of strongly salt water exist amongst the grassy islands, surrounded entirely by the fresh water of the river. Near the Northeast Pass light-house the salt water rises up visibly at one place from a depth so great that all my efforts to ascertain it failed."

The occupation of the party of Assistant Gerdes in another locality has been described under the head of Section VII. Mention will be made of its further operations on the coast west of the Mississippi.

The records of horizontal angles measured at the delta, accompanied by the usual abstract, the resulting computation for the length of triangle sides, and descriptions of the signals erected there, have been furnished to the office.

Triangulation of Côte Blanche bay, La.—In the month of February Assistant Gerdes, who had been engaged at the delta of the Mississippi, as already related, detached Sub-Assistant J. G. Oltmanns, in charge of the schooner Gerdes, to continue the triangulation of the eastern part of Côte Blanche bay, northward and westward, and, if practicable, after a reconnaissance, to push it to a connection with stations (Sketch No. 22) on the shores of West Côte Blanche bay and Marsh island. Amongst the duties assigned by my instructions was the co-operation with, and furnishing such data by the determination of new signals, and pointing out those previously established, as would facilitate the operations of the hydrographic party in Atchafalaya bay. On examination it proved that nearly all the signals of the two previous seasons were lost. The hydrographic party of Commander Sands, having arrived some time before in the steamer Walker, had re-established some signals for immediate use in making soundings. These were verified in position by the observations of Mr. Oltmanns, who also redetermined such others as were deemed essential for the work.

"Mr. Oltmanns then proceeded to the eastern part of Côte Blanche bay, but, owing to the low stage of water, the schooner could not pass Point au Chevreuil. The boats were therefore resorted to, and all the stations erected last year on the shore of that bay were revisited. Some of the signal points could not be found, and almost every one required a long search. This difficulty was chiefly caused by the entire sameness of the coast, and by the high grass and reeds which obstruct the vision beyond very short distances. Some of the stations were re-established by triangulation, and others could be found only by means of angular measurements. Fifty series of observations were made at two stations, four others being also established for continuing the work hereafter."

A reconnaissance in boats was pushed quite through to the western side of the bay with a view to develop the nature and requirements of the triangulation which was to cover it. "The investigations made prove that the triangulation and topography may proceed readily and simultaneously without material difficulties, but that the water is too shallow for any but vessels of very light draught."

Two of the stations selected on the north shore of Côte Blanche bay (West) are upwards of a hundred feet in height. One of these commands a view of the whole adjacent coast, and the practicability of its connection with the station Belle Isle, in Atchafalaya bay, is regarded as probable.

In his report Mr. Oltmanns remarks on the changes of the coast in this vicinity occasioned by almost every gale. He states that large parts of the coast which, two years ago, were familiar in outline can now be scarcely recognized. Remarkable changes were noticed on the outside reef, and, amongst other instances, he reports that the station "Centre Signal," which was occupied by the party in 1856, from the surface of the ground has at present a depth of eight feet water over it. At other places, formerly extensive shoals, he found even greater depths, and also very perceptible alterations in the outline of the marshes and swamps. "Point au Chevreuil has lost, during the last ten months, about thirty feet on all sides exposed to the water, and in a few years it will probably be entirely washed away."

Sub-Assistant Oltmanns rejoined the vessel at Atchafalaya bay early in April, and proceeding to Section VII was subsequently engaged in work at Pensacola, as already stated.

Topography of Lake Borgne and Lake Pontchartrain, La.—In continuation of the survey of the shore of Lake Borgne, Sub-Assistant Wyllys S. Gilbert resumed work in the field on the 9th of December, and completed the details of topography in the vicinity of Proctor's Point, which remained unfinished at the close of last season. A plane-table sheet was then projected, to embrace the district around Lake St. Catharine, (Sketch No. 22,) between the shores of Lake Borgne and Lake Pontchartrain, and extending beyond the Rigolets on one side, and as far as Chef Menteur, in the direction towards New Orleans, on the other.

The sheet includes the shores of West Pearl river and its branches, the Rigolets, a complete outline of the shores of Lake St. Catharine, and numerous intricate bayous connecting it with the passage last mentioned and with Lake Borgne, the adjacent shore of Lake Pontchartrain, the entire eastern shore-line of Chef Menteur, and its western shore above and below Fort Wood. Within the projected limits only a small portion of the topography of that vicinity yet remains to be executed.

The operations of Mr. Gilbert were retarded by the general inclemency of the season in this section, and by consequent sickness in his party.

"The general character of the tract surveyed is marsh, intersected with numerous bayous connecting nearly as many lagoons with the lakes. The banks of the bayous which connect Lake St. Catharine with Lake Borgne are quite firm and covered with bushes from five to eight feet high, while the shores of those which waste themselves in the marsh are very soft, and overgrown with cane varying in height from five to fifteen feet."

At the close of the season allotted for work (April 17) the schooner G. M. Bache, which had been used for the transportation of instruments and equipments, was laid up at Madisonville.

Mr. R. E. Evans aided Sub-Assistant Gilbert in the topography. The following is a synopsis of the plane-table statistics of this season:

Shore-line surveyed	220 miles.
Area of sheet, (in square miles)	55

The summer occupation of Mr. Gilbert has been mentioned under the head of Section I.

Hydrographic reconnaissance in Lake Borgne, La.—In March a hydrographic examination was made at the western end of Lake Borgne by the party of Commander B. F. Sands, U. S. N., Assistant in the Coast Survey. The space sounded is in the immediate vicinity of Bayou Dupre, and along the southern shore of the lake west of a line joining Alligator Point and Proctor's Point.

This reconnaissance was made by request, during an interval unfavorable for the general operations of the party in this section.

"The soundings show only five feet at the mouth of the bayou, the depth increasing to seven feet and more towards the deeper part of the lake."

The statistics are thus given in the summary report of Commander Sands:

Number of angles	45
Miles run in sounding	37¼
Number of soundings	2,152

The previous and subsequent occupations of the party will be now detailed.

Hydrography of Atchafalaya bay, La.—The surveying steamer Walker was fitted out for this work at the opening of the season by Commander Sands, but officers not being then available for assignment to duty, he was unable to leave the Delaware until the 4th of January. A slight accident to the engine delayed the vessel a few days at Key West, and a leak starting while at Pensacola occasioned a further detention in that harbor for repairs. The party reached the working ground, in Atchafalaya bay, on the 6th of February. Between many intervals of unfavorable weather the hydrography was vigorously pushed so as to embrace the whole of the eastern part of the bay and the entrance lying east of the meridian of Point au Chevreuil. The limit of soundings at the entrance passes westward from a point several miles south of Point au Fer light-house. Topographical points and other data requisite for the hydrographic operations were furnished by Sub-Assistant J. G. Oltmanns.

This work was closed on the 3d of May. The labors of the party are shown in the following summary of statistics, and the limits of the hydrography on Sketch No. 22.

Number of angles determined	1,840
Miles run in sounding	1,117
Number of soundings	75,951

The preliminary examination for purposes of commerce and navigation indicates that a study of the question of improvement at the entrance of this bay might have important results. This, however, is not the province of the Coast Survey.

On leaving Atchafalaya bay Commander Sands extended a line of soundings from the entrance forty miles southward into the Gulf of Mexico, and thence carried it eastward along the coast of Louisiana to the delta of the Mississippi. Three hundred and eight casts of the lead were made in the run of a hundred and seventy-three miles.

Deep-sea soundings.—From the Southwest pass of the Mississippi, Commander Sands, in the steamer Walker, carried a line for depths and temperatures across the Gulf in the direction of the Tortugas. The greatest depth found on the line (1,710 fathoms) was in a position nearly south of one in which a deep cast (1,511 fathoms) was made in the previous year. At the next station eastward 2,100 fathoms of line were payed out without indicating bottom. This was in a position north of the passage between the western end of Cuba and Yucatan.

The temperatures were observed at the surface at 50 and 100 fathoms, and at the bottom, in twenty-two different positions, the lowest (34 degrees) being obtained at a depth of 896 fathoms, about a hundred and twenty miles from the Delta. The surface temperature in the same position was 77 degrees.

Allusion has already been made, under Section VI, to the continuation of this line of soundings eastward of the Tortugas.

The steamer Walker arrived at Philadelphia early in June. Arrangements are now making for her return with the hydrographic party to this section, in charge of Lieut. Comg. T. B. Huger, U. S. N., Commander Sands having been detached from the Survey at the end of

September. All the outstanding records, journals, and the charts of the present season connected with the work of that officer, have been received at the office.

In the withdrawal of Commander Sands the Survey has lost one of the most experienced officers who have as yet co-operated in it. The inclination that led him, at an early period, to take part in the field-work, was probably the basis of that devotion shown, as an officer of the navy, in his later association with its hydrographic operations.

As a hydrographer, and generally engaged in a remote section of the coast, his energy was always equal to the obstacles which naturally interposed in its execution. He never lost any opportunity of adding to the general stock of information in passing from one section of the Survey to another, by observations of depths, currents, temperatures, and the like, and he never returned from a season's work without a rich harvest of results, as well incidental as those of routine.

SECTION IX.

FROM VERMILION BAY TO THE BOUNDARY, INCLUDING PART OF THE COAST OF LOUISIANA AND THE COAST OF TEXAS.—(SKETCH I, No. 24.)

The progress of the land work in this section has been what I had anticipated in my last report; but the obstacles which I then stated would probably delay the hydrography have occurred in even a worse form than I had foreseen, for it was not possible to replace the hydrographic chief who had been detached by the Navy Department from the Coast Survey. I endeavored to remedy this by assigning a steam vessel to the service in Sections VII and IX, but the vessel being overtaken by a storm and injured, her services in Section IX were hardly more than nominal. I shall probably be compelled to give another trial to the same plan of working, but shall do so with reluctance.

The work of the season has included a plane-table reconnaissance for the triangulation of the coast of Texas between Matagorda and Corpus Christi bays, the topography of the shores of Lavaca bay, and the hydrography of the Brazos river, from its mouth to Velasco.

Office-work.—A map of the entrance to Matagorda bay, $\frac{1}{40000}$, has been drawn, and two finished maps of the coast of Texas, (Nos. 105 and 106,) extending from east of Galveston bay to Oyster bay, $\frac{1}{80000}$, are in progress.

The engraving of preliminary chart No. 31, $\frac{1}{200000}$, from Galveston to Matagorda bay, has been completed. The chart of the entrance to Matagorda bay has been engraved upon stone under the direction of the Superintendent of Public Printing.

Reconnaissance between Matagorda and Corpus Christi bays, Tex.—In order to develop fully the requirements and resources for the triangulation and topography of the coast of Texas, between Matagorda entrance and Aransas Pass, a complete reconnaissance has been made of the shores of Espiritu Santo, San Antonio, and Aransas bays, and of Matagorda and St. Joseph's islands, which separate them from the waters of the Gulf of Mexico. This duty was executed by the party of Assistant S. A. Gilbert, and the results, in advance of the finished survey, have added much to our essential knowledge of that region for the purposes in view. The shore line and other principal features, as hitherto represented, have been found to differ rather more widely from nature in this part of the section than on any other part of the coast which has yet been included in the detailed survey.

Assistant Gilbert took the field on the 1st of March, commencing at the south side of

Matagorda entrance. In the progress of his operations southward and westward he selected sites suitable for stations in the triangulation, (see Sketch No. 24,) and has furnished a scheme for its execution. Tripod signals were erected at seven stations and used in the reconnaissance. In various localities, where the intricacy of the navigation rendered it desirable, plane-table surveys were made, the aggregate of which represents ninety miles of shore-line on the preliminary map of the region. All the principal dependencies of Espiritu Santo, San Antonio, and Aransas bays were included in the examination. The reconnaissance was extended over an area of about seven hundred square miles.

Assistant Gilbert incidentally made soundings as the work advanced, and observed for the average rise and fall of the tide, to determine the means of transportation needed in future, there being as yet no pilots engaged on this part of the coast of Texas, nor any other than very general charts of the vicinity, excepting the sketch of a hydrographic reconnaissance made at Aransas Pass in 1851 for light-house purposes, and issued from the Coast Survey Office.

The original sheet, completed by Assistant Gilbert after the close of his operations in June, has been placed in the archives.

Sketch No. 28, accompanying this report, represents the resulting map of the reconnaissance between Matagorda and Corpus Christi.

In the field-work Assistant Gilbert was aided by Mr. Charles Hosmer.

Before taking the field for the season, Assistant Gilbert sent to the office four volumes containing the abstracts of horizontal angles determined on the coast of Texas in the years 1855, 1856, and 1857. He is now making arrangements for prosecuting the triangulation of the coast and adjacent bays below Matagorda entrance.

Topography of Lavaca bay and its dependencies, Texas—The plane-table work in this quarter, which hitherto followed the triangulation at the distance of one season, has been brought even with it by the completion of the survey of the shores of Lavacca bay and its tributaries. For this duty the party of Sub-Assistant Malcolm Seaton resumed operations on the 19th of January. Throughout the winter and in April the weather proved quite unfavorable, and the period spent in the field in completing the sheets laid out for execution was in consequence protracted until the 30th of June. Besides the main shores of the bay the sheets returned (Sketch No. 24) contain the shore-lines of Big Chocolate and Little Chocolate bayous, Linn's bayou, Six Mile creek, Placido or Union river, Lavaca river, Benado and Garcitas creeks, Fish Lake bayou, Cox's bay and creek, Keller's bay and creek, and Powder Horn bayou. The town of Lavacca was also surveyed, and is represented with the usual topographical details.

The shore-line of Matagorda bay and its dependencies is now essentially complete, only the town of Indianola yet remaining to be traced on the sheet of that vicinity.

"The entrances and merely the lower portions of the rivers, creeks, and bayous enumerated were surveyed, as no remarkable topographical features are distinguishable in ascending them. They are all shoal at their entrances, with deep water inside. Lavaca river, which is the most considerable, has a bar at its mouth with only two and a half to three feet water on it at good tides, while above there is sufficient to float large vessels.

"The topography just executed is of the same character as that of Trespalacios and Carankaway bays, described in my report of last year."

A synopsis of the statistics is thus given by Sub-Assistant Seaton:

Main shore-line	60	miles.
Interior marsh-line	52	"
Roads	35½	"
Creeks and bayous	38½	"
Streets and wharves	12½	"
Area embraced, (in square miles).	69	

Mr. T. C. Bowie served acceptably as aid in the party.

Active operations are now about to be resumed for continuing the topography of the coast of Texas below Matagorda entrance.

Hydrography of Brazos river, Tex.—There being no separate party available for continuing the hydrography of the coast of Texas above Matagorda entrance, the latter part of the working season was employed by Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey, with the steamer Vixen, in making a preliminary survey of the bar, entrance, and channel of the Brazos, to a point a little above Velasco. The vessel had been previously engaged in Section VII, and did not reach Galveston until the close of May.

In reference to the result of his examination, Lieut. Comg. Duer says: "I found more water than had ever been reported before, (there being nine feet at high tide,) but the bar, as was represented to me, had recently shifted, and a late freshet in the river had moved it outward. It is probable that it will so remain until the first strong easterly gale.

"From what I could ascertain it would appear that the bar varies in depth and shifts frequently, so as to render the result of any particular survey very uncertain for subsequent reference. * * * * * * * * * *

"Off the mouth of the river there is good holding ground at the anchorage, the bottom being of red mud, in from four and a half to six fathoms water; but a very heavy swell sets in to this part of the coast at times, and although it would seem impossible for ships to drag, there is great danger of them parting their cables. Several vessels have been wrecked here. Ships, however, with good ground tackle, might be loaded by means of lighters during the cotton and sugar season, when gales on shore are not frequent."

Lieut. Comg. Duer has sent to the office the hydrographic sheet and record books containing entries of the soundings taken, and the angles observed in the work at Brazos entrance.

The hydrographic reconnaissance of the Brazos river comprises the following statistics:

Angles determined	103
Miles run in sounding	24
Number of soundings	1,550

The tides were observed in connection with the soundings. This survey was made in June, and the season having been protracted beyond the usual period for work in the section, Lieut. Comg. Duer started for New York on the 24th of that month.

On the passage of the steamer Vixen a line of soundings was run along the coast from the mouths of the Mississippi to Galveston bar, a similar line with temperature observations being also made on the return.

SECTION X.

FROM THE SOUTHERN BOUNDARY AT SAN DIEGO TO THE FORTY-SECOND PARALLEL, INCLUDING THE COAST OF CALIFORNIA.—(SKETCH J, NOS. 29 AND 30.)

The usual number of parties has been at work in this section. The appropriation of thirty thousand dollars for the survey of the Western Islands, which has been granted for several years, was not made for the present fiscal year, but the balance on hand permitted the continuance in the field of the triangulation party heretofore engaged in that work.

During the year Lieut. Comg. R. M. Cuyler has been relieved from the command of the hydrographic party, which has been temporarily resumed by Commander James Alden.

Assistant G. A. Fairfield has been ordered to the Atlantic States, and the primary triangulation and astronomical work of the section have been assigned to Assistant George Davidson. Sub-Assistant Augustus F. Rogers has been relieved, to return to the Atlantic States, his party being temporarily in charge of Mr. David Kerr.

The operations of the season have been as follows:

1. Primary triangulation of the main adjacent to Santa Barbara channel, Cal., and secondary triangulation of San Nicolas and San Miguel islands.

2. Progress made in primary work at Tomales Bay Station, and secondary triangulation of Petaluma creek, San Pablo bay.

3. Triangulation and topography of Napa creek, San Pablo bay.

4. Topography of Santa Cruz island and vicinity of Point Duma, Santa Barbara channel.

5. Topographical resurvey of San Francisco city and its environs.

6. Verification of hydrography off the wharves of San Francisco city; soundings in the southeastern part of San Francisco bay completed, and progress made in the hydrography of the approaches to the Golden Gate.

7. Observations with self-registering tide gauges at San Diego and San Francisco in this section, and at Astoria in Section XI.

Office-work.—The following drawings belonging to this section have been completed: Monterey bay, $\frac{1}{60000}$; additions to San Francisco entrance, $\frac{1}{50000}$; and Humboldt bay, $\frac{1}{30000}$. The finished map of San Francisco bay and vicinity, $\frac{1}{80000}$, has been in progress.

The engraving of the charts of San Diego bay, eastern entrance to Santa Barbara channel, San Antonio creek, and Monterey bay as preliminary has been completed.

Primary triangulation of the coast of Santa Barbara channel, Cal.—Satisfactory progress has been made in this work since the date of my last report by the party in charge of Assistant W. E. Greenwell. He resumed observations on the 9th of November, and during the winter completed the angular measurements at three primary stations. At the end of September the triangulation had been extended westward as far as San Buenaventura, (Sketch No. 29,) a few miles west of the entrance of the Santa Clara river. The latter part of the season was employed in the triangulation of the islands of San Nicolas and San Miguel. On the main, opposite to the island of Santa Catalina, the observations necessary for connecting it with the primary triangulation are now complete. The eastern end of Santa Cruz island and the station on Anacapa have also been observed on from the two adjacent primary stations on the main.

"The main stations, as well as all occupied or erected for this work, are marked with red stone monuments, and will remain permanent in all time to come."

At the date of the last report from Assistant Greenwell, the prospects were favorable for completing the connection of Santa Cruz island with the triangulation of the main coast. The following statistics were presented at that time:

Primary stations occupied	3
Primary signals erected	6
Number of observations	1,587

Mr. P. C. F. West aided Assistant Greenwell until April, when he was transferred to the party of Sub-Assistant J. S. Lawson, and assigned to duty in Section XI.

In prosecuting the primary triangulation on the main, and the secondary work on the islands of the Santa Barbara channel, the schooner Humboldt was used for transportation.

Triangulation of San Nicolas and San Miguel islands of the Santa Barbara group.—After measuring a preliminary base of 619.8 metres, Assistant Greenwell laid out and executed on the island of San Miguel an interior triangulation sufficient for the requirements of the topographical party. He completed also the work on San Nicolas, good progress in which had been made at the date of my last annual report.

"The surface of San Nicolas is a table land of five or six hundred feet elevation and destitute of wood or grass, but good water is found on it at several places.

"San Miguel is somewhat similar in respect of soil, but with very little water, and like San Nicolas is destitute entirely of wood. These two islands are unclaimed and are probably government property."

The statistics of the secondary work are thus stated in the report of Assistant Greenwell:

Stations occupied	19
Signals erected	25
Number of observations	2,208

All the angular measurements were made with the eight-inch Gambey theodolite, C. S. No. 44.

The area embraced in the operations of the season is about nine hundred square miles.

At the opening of the surveying year Assistant Greenwell sent to the office six volumes containing duplicates of his records of horizontal angles determined in the work on the shores of Santa Barbara channel and on Santa Cruz island.

In September the main stations on Santa Cruz and Anacapa islands, and two connecting with them on the coast, were visited and made secure against disturbance, after which the party returned to San Francisco in the schooner Humboldt.

The primary work on the shore of Santa Barbara channel has since been resumed, and is at this date in progress.

Primary triangulation north of San Francisco bay, Cal.—Progress has been made in the extension of this work by Assistant G. A. Fairfield, whose party occupied the primary station at Tomales bay from the outset of the surveying year until after midsummer. Notwithstanding the hindrances from almost constant fogs, the observations were nearly completed, only one angle now remaining to be finally determined.

The secondary triangulation of Tomales bay was finished at the opening of the present season. Both schemes will be seen by reference to Sketch No. 30. Mr. C. B. Ellis, the aid in the party, remained at the primary station while Assistant Fairfield executed some secondary work, which will be noticed under the next head.

The instruments and camp equipage were removed from Tomales bay in July and stored at San Francisco to await the arrival of Assistant George Davidson, to whom has been assigned the duty of continuing the triangulation northward from its present limit. Mr. Fairfield soon after returned to the Atlantic coast and reported at the office in Washington.

Triangulation of Petaluma creek, San Pablo bay, Cal.—At the commencement of the surveying year a reconnaissance for the selection of stations between the town of Petaluma and San Pablo bay was made by Assistant Fairfield. Ten signals were erected so as to embrace by connecting lines from an equal number of stations on either side (Sketch No. 30) the entire course of Petaluma creek below the town, and including also its entrance into San Pablo bay. The angular measurements were completed by the end of December, and the results of the triangulation at once computed and furnished to Sub-Assistant A. F. Rodgers, for topographical purposes. The following are the statistics of this work:

Stations occupied	11
Angles determined	37
Number of observations	964

On the departure of Sub-Assistant Rodgers from the Western Coast the plane-table survey of Petaluma creek devolved on Mr. David Kerr.

Triangulation and topography of Napa creek, San Pablo bay, Cal.—In the middle of March Sub-Assistant A. F. Rodgers selected as a base the line "Mare island, (NW. station,) Vallejo (1,)" the length of which had been determined in the general triangulation of San Pablo bay, and following his own reconnaissance of the previous season carried a net work of triangles (Sketch No. 30) from that line to the town of Napa, at the head of navigation on Napa creek. This was intended to serve as a basis for the topographical survey, the execution of which was entrusted to Mr. David Kerr, the aid in his party. Fifteen signals were erected and observed on in the measurement of the angles.

The general statistics of the work are as follows:

Stations occupied	13
Angles measured	90
Number of observations	270

Eighteen points were determined in geographical position as the result of this triangulation.

Having completed this duty Sub-Assistant Rodgers returned to San Francisco at the end of March, and soon afterwards left the Pacific coast. He reported at the Coast Survey Office in May. During his absence on Napa creek Mr. Kerr remained at San Francisco in charge of the office-work of the party. On its completion the plane-table survey was commenced and carried upward within the limits of the triangulation from the mouth of the creek towards Napa. The distance measured in the axis of the triangulation is about twelve miles, but much greater by the tortuous course of the stream. Good progress was made in the summer, and by the 1st of October both shores had been traced and the immediate topography executed as far as the town of Napa.

In a report just received from Mr. Kerr the following statistics are given as derived from the plane table sheet:

Shore-line of creeks and branches	163.88 miles.
Shore-line of marsh	37.50 "
Shore-line of ponds	10.37 "
Roads and fences	80.75 "
Area, (in square miles)	31¼

At this date the survey of Petaluma creek is about to be commenced.

Topography east and west of Point Duma, Cal., and survey of part of Santa Cruz island.—The plane-table work on the main coast of Santa Barbara channel has been advanced eastward from a station two miles west of Point Duma, and now includes that cape and the coast a short distance beyond the Corral Viejo, where the eastern limit of the sheet projected for the vicinity terminates.

With reference to light-house purposes, Point Duma was carefully surveyed, (Sketch No. 29,) and in January, Sub-Assistant W. M. Johnson, who has charge of the work in this quarter, communicated the following as data derived from his plane-table sheet: "The altitude of the trigonometrical station at Point Duma is 202 feet above high water, and the angle of visibility, including the bay to the eastward, is 222½ degrees. On account of thick weather which prevailed while the party was employed there, it was not practicable to get lines to Point Vincent and the island of Santa Catalina."

Having completed the field-work of the sheet just referred to, Mr. Johnson commenced inking it and others which embrace the main to the westward as far as San Buenaventura and part of the coast eastward of Point Vincent. Sub-Assistant C. M. Bache assisted in this and in the field duty. In the course of the season five sheets were inked, four of which have been received at the Coast Survey Office.

The plane-table party resumed active service in the middle of June, having been transferred to Santa Cruz island by Assistant Greenwell, in the schooner Humboldt. On a sheet laid out to embrace Prisoners' harbor, on the north, and the opposite southern shore of the island, the following details have been traced:

Shore-line	3½	miles.
Roads	3½	"
Area, (in square miles)	3	

Topography of San Francisco city, Cal.—At the date of my last annual report the new survey of San Francisco was well advanced towards completion. The detailed work rendered necessary by the changes which had occurred in four years of unusually rapid development was continued during the winter at favorable intervals by Sub-Assistant Augustus F. Rodgers, aided by Mr. David Kerr, and completed early in the spring. The sheet (Sketch No. 31) representing the water front of the city as then existing, and the minute topography of the city and environs, was inked without delay and reached the Coast Survey Office early in May.

On the withdrawal of Sub-Assistant Rodgers from the Western Coast, reference to which has already been made, the charge of this plane-table party, and of the schooner Baltimore, devolved upon Mr. Kerr.

Since the opening of the surveying year ten topographical sheets of the shores of San Francisco bay and its principal dependencies, including that of the resurvey of San Francisco city have been forwarded to the office by Sub-Assistant Rodgers.

Supplementary soundings in San Francisco bay, and hydrography outside of the Golden Gate.—On being relieved from duty for the winter with the Northwest Boundary Commission, Lieut. Comg. R. M. Cuyler, U. S. N., Assistant Coast Survey, returned to San Francisco in the steamer Active, and employed the early part of the surveying year in making additional soundings in front of the wharves of that city, great changes being known to have taken place there since the survey of 1852. This duty was satisfactorily completed before the end of November. He then took up and prosecuted the supplementary hydrography of the southeastern part of San

Francisco bay below San Antonio creek, filling with soundings the unfinished parts of three sheets projected to include the whole of the bay below Point Avisadera. These separate limits will be found marked on the progress sketch, (No. 30.) The following is a synopsis of the statistics:

Miles run in sounding	676
Angles determined	2,097
Number of soundings	20,496

The supplementary work just referred to occupied the party until the middle of February.

After making the needful preparation, Lieut. Comg. Cuyler commenced the hydrography of the approaches to the Golden Gate, with the intention of running lines of soundings so as to develope the character of the bottom from the entrance of San Francisco bay westward to a line beyond the meridian of Point Reyes and southward from that point to a parallel below the Farallones. On the first day out the Active was unfortunately disabled by the bursting of her steam pipe, which accident occasioned a delay of ten days for repairs. The work was then resumed and continued as the weather would permit until the middle of May, but the prevalence of haze and fog made it impracticable to keep up a steady rate of progress.

As far as now advanced, the following statistics show the condition of the hydrography:

Miles run in sounding	213
Angles determined	84
Number of soundings	361

After the return of the steamer Active to San Francisco, Lieut. Comg. Cuyler proceeded to the vicinity of the "Brothers," near the entrance of San Pablo bay, and determined the position of a very small sunken rock on which the steamship "Golden Gate" had struck in one of her passages to Benicia. The depth reported by him is twelve feet at mean low water. A reef on the Contra Costa flats was also examined and its position determined. Both of these dangers are described in Appendix No. 18, and have been marked on the charts. At the request of Major Hartman Bache, light-house inspector for the district, Lieut. Comg. Cuyler determined, in December last, the position of all the buoys in the harbor and on the bar of San Francisco bay. Incidental service was also rendered by the party in recovering and replacing the bell-buoy, which had broken adrift from its mooring in the harbor, and in towing the sloop-of-war St. Mary's to Mare Island navy yard.

Commander James Alden, U. S. N., having been reassigned by the Navy Department for Coast Survey duty, proceeded to San Francisco in June, and on his arrival Lieut. Comg. Cuyler, having meanwhile made such repairs as were immediately required on the steamer Active, returned that vessel to his command. The last named officer then proceeded to the Atlantic coast, and reported at Washington in July.

After communicating with the Commissioner, Archibald Campbell, Esq., Commander Alden sailed for Washington sound, (Section XI,) where his vessel and the hydrographic party were placed at the disposal of the State Department for duty connected with the determination of the northwestern boundary line of the United States.

Six original sheets, concluding the hydrographic survey of San Francisco bay and its dependencies, have been received within the year from Lieut. Comg. Cuyler, and registered in the office. At the present date Commander Alden is engaged in prosecuting the hydrography off shore from San Francisco entrance. In the middle of November, while so employed, the ship *Lucas* was stranded, and about twenty persons lost their lives in attempting to reach the shore from the wreck. The survivors, about one hundred and fifty in number, were taken from the rocks of the Farallones and conveyed in the steamer Active to San Francisco.

Tidal observations.—The permanent tidal stations at San Diego and San Francisco (Section X) and at Astoria (Section XI) have been kept up successfully during the entire year, under the able direction of Lieut. G. H. Elliot, of the Corps of Engineers, and with the concurrence of the chief engineer.

Observations were also made, under the supervision of Lieut. Comg. R. M. Cuyler, U. S. N., Assistant in the Coast Survey, at Sacramento city, Mare Island navy yard, Benicia, and Ravenswood, in San Francisco bay, and at Semi-ah-moo bay, Washington Territory, (Section XI,) in connection with general operations for the boundary survey of the United States.

SECTION XI.

FROM THE FORTY-SECOND PARALLEL TO THE NORTHWESTERN BOUNDARY, INCLUDING THE COAST OF OREGON AND WASHINGTON TERRITORIES.—(SKETCH K, No. 33.)

The work in this section has been directed under the law relating to the northwestern boundary, principally to co-operation with the Commissioner, Archibald Campbell, esq., in his labors. It has consisted of—

1. Triangulation in the lower part of the Gulf of Georgia, W. T.
2. Topography of the islands adjacent to the northern entrances of Canal de Haro and Rosario strait.
3. Hydrography within the limits of the season's triangulation in the Gulf of Georgia, W. T.
4. Tidal observations at Astoria, Oregon Territory.

The reports from the Western Coast were received soon after the introduction was written, and the notices were completed accordingly. By inadvertence the statement on page 11 of the introduction was retained.

Office-work.—Additions to the sketch of Canal de Haro and Straits of Rosario, $\frac{1}{200000}$, and a sketch of Semi-ah-moo bay, W. T., $\frac{1}{30000}$, have been drawn.

Triangulation in the Gulf of Georgia, W. T.—In order to meet the requirements of the Commissioner on the northwestern boundary of the United States, Sub-Assistant James S. Lawson was reassigned to duty in this section. He reached San Francisco on the 19th of April, and, after the completion of repairs on the surveying brig Fauntleroy, proceeded northward in that vessel and arrived at Port Townshend on the 2d of May.

Mr. Lawson commenced at Hale's Passage an examination of the stations of previous years. Several which had been destroyed by the Indians were restored, and an additional number were erected on the eastern shore of the Gulf, between Lummi island and Point Roberts, and on the islands forming its southern boundary, sufficient for the purpose of the plane-table and hydrographic surveys. The western limit of the work, the scheme of which is marked on Sketch No. 33, includes the whole of Saturna island.

The triangulation was then pushed forward, twenty-three stations being occupied in the course of the season.

One hundred and ninety angles were measured on a hundred and sixty-nine objects, by five thousand seven hundred and forty-four observations.

In addition to thirty-one new signals erected, ten others, some of which had been thrown down, were readjusted.

In order to assist in filling in the shore-line, thirty-four subsidiary points were marked, and seven hundred and eighty-seven readings taken, upon secondary objects.

The instruments used were the Gambey theodolites, ten-inch, C. S. No. 20, and six-inch, C. S. No. 21.

Vertical angles were measured at six stations on twenty-one objects, by one hundred and ninety-five repetitions, with the Gambey vertical circle, C. S. No. 80.

The following is an extract from the report of Sub-Assistant Lawson:

"In the execution of this work I had to contend against two very serious obstacles—the very great refraction that almost continually exists along some part of these shores, and the drawback in the destruction of signals by the Indians. At times the refraction affects only circumscribed localities, and can be detected only by the discrepant observations; at others it is very general. A range of ten or fifteen seconds is by no means uncommon, and in one instance a range of thirty-three seconds was noticed between the different series. The mischief done by the Indians was a great grievance at the outset, and occasioned much loss of time. One of the signals, twelve miles from the vessel, being torn down twice in succession, could be reached only by crossing dangerous tide-rips and pulling against the strong currents for which these waters are noted."

In connection with the triangulation of the Gulf of Georgia, Mr. Lawson endeavored to determine the positions of some of the peaks of the Cascade range of mountains.

"The summit of Mount Baker presents a slightly rounded appearance, with no well defined object upon it to serve for a pointing, and hence the result for position is somewhat unsatisfactory. Its approximate place was determined from three bases, of 13.52, 14.32, and 15.68 statute miles in length. The altitude was determined from two stations, giving a mean result of 10,814 feet.

"The positions and altitudes of several of the peaks south of Mount Baker were also determined."

Sub-Assistant P. C. F. West joined Mr. Lawson on the 29th of May, and assisted him in all the operations of the season.

Topography of the Gulf of Georgia, W. T.—As the most essential duty of the land party, for the purposes of the commission on the northwestern boundary and for the hydrography of the Gulf of Georgia, Sub-Assistant J. S. Lawson traced on three plane-table sheets about a hundred miles of the shore-line falling within the limits of his triangulation of the early part of the season. One of these embraces a portion of the eastern shore of the Gulf of Georgia, from Cherry Point station southward to Lummi island, and thence westward to include Matia, Sucia, and Patos islands, East Point, (Saturna island,) and the eastern end of Tumbow island. This sheet gives the northern boundary of the archipelago lying between Rosario strait and the Canal de Haro, with the northern entrances to both of those channels.

The second sheet commences at Canal de Haro, and runs westward, taking in Tumbow island, Bell's chain, and the north shore of Saturna and other islands, as far as Disappointment station, where a third sheet begins, and includes the entrance of a fine passage, now much used by steamers, and the remaining points determined by the triangulation. The three sheets were made on a scale of $\frac{1}{20000}$, and tracings of them were promptly furnished to the hydrographic party. For general purposes a fourth sheet was constructed on a scale of $\frac{1}{100000}$, to include the entire work of the season.

The usual meteorological observations were recorded by the party of Sub-Assistant Lawson.

Between May 19 and September 27, the quantity of rain falling in thirty-five days, as determined by observation, was 5.269 inches.

Four volumes, containing the meteorological observations recorded by the party of Assistant George Davidson, while employed in this section, have been furnished by him and placed in the office.

Hydrography of the Gulf of Georgia, W. T.—From the points of reference and shore line furnished by the land party, Commander James Alden, U. S. N., Assistant in the Coast Survey, has executed a considerable part of the hydrography of the Gulf of Georgia. Soundings were commenced on the 24th of August, and continued until the 10th of October. The result is the entire development of the bottom eastward of a line joining Point Roberts and Active passage, (Sketch No. 33) and as far southward as the entrances of Canal de Haro and Rosario strait. In order to show more clearly the character of the approaches to the passages just named, a sheet on a scale of $\frac{1}{20000}$ was projected within the limits of the general sheet, and the soundings made closer in proportion as compared with the hydrography of other parts of the Gulf. The operations of the land party having been retarded by causes already alluded to, it was found impracticable to complete all the soundings which may be required by the commission on the boundary.

The hydrography now includes Mud bay and Birch bay, and in a line joining them connects with the soundings, made last year in the eastern part of the Gulf by Lieut. Comg. R. M. Cuyler, U. S. N.

The statistics of the season are as follows:

Miles run in sounding	847
Angles taken	3,067
Number of soundings	7,742

Sixty specimens of bottom taken in sounding were preserved for analysis. The commander of the British surveying vessel in the quarter adjacent to the boundary having attached the name of Commander Alden to a shoal discovered by that officer in the lower part of the Gulf of Georgia in 1853, the designation has been adopted and the bank will be so marked on the Coast Survey charts.

The hydrographic party in the steamer Active returned to San Francisco in the middle of October.

In moving from station to station in a boat from the brig Fauntleroy, Sub-Assistant P. C. F. West, of the land party in charge of Sub-Assistant Lawson, discovered a bank lying off the southwest end of Sucia island, and in a line between the eastern end of Patos island and Point Doughty. The preliminary examination gives indications of considerable extent, and as little as three and a half fathoms has been found. The result of the examination by the hydrographic party has not yet been reported.

The sheet containing the soundings stated in my last annual report as having been made in Semi-ah-moo bay, near the northwestern boundary, by the party then in charge of Lieut. Comg. R. M. Cuyler, has been received at the office. A synopsis of the statistics returned since the date of that report is as follows:

Miles run in sounding	122
Angles determined	166
Numbers of soundings	1,485

An engraved reduction from the hydrographic sheet will be seen in sketch No. 37.

Tidal Observations.—A regular series recorded on the self-registering tide-gauge at Astoria has been kept up under the charge of Lieut. G. H. Elliot, of the Corps of Engineers.

Light-house site.—An examination in regard to the relative eligibility of Point Wilson and Red Bluff, (Admiralty Head,) W. T., as a location for a light-house, has been made and reported upon by Commander Alden. A copy of my communication to the department, transmitting the views of that officer upon the subject, will be found in the Appendix, (No. 45.)

OFFICE-WORK.

During the first six months of the past year the Coast Survey Office has been in charge of *Captain M. L. Smith, United States Topographical Engineers*, and during the second, of *Captain W. R. Palmer*, of the same corps. The report of Captain Palmer, (Appendix No. 19,) gives a brief but clear statement of the work done, and I agree with him in his judgment of the general efficiency of the establishment. *Lieuts. A. P. Hill and J. P. Roy, U. S. A.*, have rendered valuable aid as general assistants from time to time.

1. COMPUTING DIVISION.—This division, which is one of the most efficient of the office, has continued under the charge of *Assistant Charles A. Schott*, whose report shows the details of work executed, and who finds time in the midst of severe routine labors to discuss various mathematical and physical problems coming within the scope of his division. Appendix Nos. 25 and 26 contain papers by him on the secular change of the magnetic declinations, from observations at Washington, D. C., and Hatboro', Pa. The distribution of work between the gentlemen employed in the division has not differed materially from that of last year. *Assistant T. W. Werner* has been employed on reductions of triangulations and of latitudes; *Mr. Eugene Nulty* on reductions of latitude and longitude observations; *Mr. James Main* on those of latitudes, longitudes, and azimuths, and magnetic observations; *Mr. G. Rumpf* on geographical positions and triangulations; *Mr. John Wiessner* on triangulations, adjustments by least squares, latitudes, &c.; *Mr. W. D. Storke*, who replaced *Mr. J. E. Blankenship*, on triangulations and miscellaneous computations; *Mr. John T. Hoover* acted as clerk to the division, assisted in preparing geographical positions, and in making magnetic observations.

2. TIDAL DIVISION.—This division has remained under the charge of *Assistant L. F. Pourtales*. The tidal discussions, under my immediate direction, have been continued, and Mr. Pourtales has devoted himself chiefly to the examination of the specimens of bottom collected in the soundings. *Mr. R. S. Avery* has continued the discussion of the tides of Boston harbor. *Mr. S. Walker* has been engaged in graphical decompositions of the Florida reef observations, and in reading off the observations of the self-registering tide-gauges, and in clerical duties of the division; *Mr. J. Downes* has, since January, been engaged on the Florida tides; *Mr. G. C. Blanchard* was occupied in ordinary tidal reductions up to the time of his resignation in March; *Messrs. R. E. Evans, C. Fendall, and D. Trueheart*, attached for short periods to the division, were employed in miscellaneous reductions. The meteorological observations of the tidal observers on the Pacific coast have been reduced by *M. Thomas*, and tidal observations at the permanent stations by *S. D. Pendleton.*

3. DRAWING DIVISION.—Captain Palmer reports that this division has continued to gain upon the drawings for the engravers. It is still under the charge of *Lieut. J. C. Tidball, U. S. A.*, assisted by *Mr. G. A. Porterfield*, as clerk to the division. *Assistant W. M. C. Fairfax* has been occupied with first class topographical reductions; *Assistant J. McClery* on additions to the Congress map and first class topographical reductions; *Mr. James J. Ricketts*

on hydrographic reductions to the date of his resignation, February 1. *Mr. A. Boschke* on projects for maps and charts; *Mr. L. D. Williams* on preliminary and general coast charts, on the Congress map, and making projections and verifications; *Mr. A. Lindenkohl* on topographical reductions, preliminary charts, and Land Office maps; *Mr. A. Balbach* on hydrographic reductions, comparative charts, and miscellaneous work; *Mr. W. P. Schulz* on harbor charts, progress sketches, projects, and projections; *Mr. A. Strausz* on hydrographic reductions and original sheets; *Mr. W. T. Martin* on topographical and hydrographic reductions; *Mr. P. Witzel* on harbor and river charts, on progress sketches, projections, and miscellaneous work; *Mr. F. Fairfax* on harbor and river charts, comparative maps, and tracings for photographic experiments; *Mr. A. Schoepf* on harbor charts; *Messrs. B. Hooe, S. B. Linton,* and *W. T. Bright,* and *Artificer J. A. Campbell* on tracings, diagrams, and miscellaneous work.

4. Engraving Division.—This has remained under the charge of *Lieut. Rufus Saxton, U. S. A.*, assisted by *Mr. Edward Wharton,* whose services Lieut. Saxton acknowledges in his report.

The class of occupation of the different engravers has not varied much through the year. *Mr. G. McCoy* has been employed on topography and views; *Mr. F. Dankworth* on topography; *Mr. John Knight* on first class lettering; *Mr. Enthoffer* on topography; *Mr. A. Rollé* on topography; *Mr. Sengteller* on topography of harbor and coast charts; *Mr. Metzeroth* on topography of harbor and of river charts; *Mr. Blondeau* on topography; *Mr. Phillips* on topography; *Mr. A. E. Maedel* on harbor and preliminary charts; *Mr. Throop* on lettering and figures of harbor and preliminary charts; *Mr. Kondrup* on outlines, letters, and figures; *Mr. A. Maedel* on topography, outlines, and lettering of harbor charts; *Mr. Barnard* on sanding and topography; *Mr. Langran* on letters and figures of harbor and preliminary charts; *Mr. Petersen* on topography and lettering of harbor and preliminary charts; *Mr. Bartle* on sketches and miscellaneous work; *Messrs. Benner, Thompson,* and *Apprentice Sipe* on progress and other sketches and miscellaneous work.

5. Electrotype Division.—*Mr. George Mathiot's* useful labors in this division have been interrupted by illness during the year; notwithstanding which his zeal has enabled him to keep pace with the office requirements, and to continue to improve his branch. The application of photography to reductions is steadily kept in view, and the arrangements now made will, it is expected, render it part of the regular office-work during the coming year. The application to the change of scale of reduced drawings is complete, and the effort is now making to reduce from the original plane-table sheets.

6. Miscellaneous Division.—A division consisting of the printing office, the map room, and office for the distribution of the maps and charts, and of the Coast Survey Report, has been organized and placed under the charge of *Lieut. J. P. Roy, U. S. A.* Eleven thousand nine hundred and five copies of maps, charts, sketches, and diagrams have been printed within the year by *Mr. John Rutherdale.* Eleven thousand eight hundred and fifty-two copies of maps charts, and diagrams, and eight thousand and thirty-five copies of the annual report of the Superintendent of the Coast Survey have been distributed by *Mr. V. E. King.* The number of copies of the annual report of 1856 distributed within the past year has been 6,679; of 1855, 1,069; of 1854, 117; of 1853, 93; of 1852, 48; of 1851, 29; those prior to 1851 are out of print. The distribution extends throughout all the States and Territories of the Union.

Of the report of 1857 5,000 copies have been directed to be distributed from the Coast

Survey Office by resolution of the Senate, and 3,000 by resolution of the House of Representatives.

Library and archives.—These have been continued under the charge of *Mr. C. B. Snow.* During the calendar year 1858 forty-five volumes have been added to the library, of which fourteen were presented to the Survey.

Instrument shop.—*Mr. J. Vierbuchen* and six assistant instrument makers have been engaged in making and repairing instruments during the year. A general list of the work done, as well as of that in the *carpenter's shop* in charge of *Mr. A. Yeatman*, with one workman and an apprentice, is given in Appendix No. 19.

The work on records and results, under the charge of *Assistant J. E. Hilgard;* of *Assistant L. F. Pourtales*, in charge of tidal researches; of *Lieutenant E. B. Hunt*, in reference to an index of scientific matters; of *Professor W. P. Trowbridge*, on the Gulf Stream, deep-sea soundings, and the like; of *Mr. J. M. Batchelder*, on special experimental inquiries, have generally been noticed in the introduction to my report, being under my immediate direction.

Lieutenant J. N. Maffitt, U. S. N., served, temporarily, most acceptably in charge of the hydrographic division of the office, which, since his orders to sea, has been without a chief.

I must again express my high sense of the value of the services of *Samuel Hein, esq.*, general disbursing agent of the Coast Survey, the effects of whose constant assiduity and systematic efforts are felt much beyond the limits of his office; also of those of my principal clerk *W. W. Cooper, esq.*, whose faithful, intelligent, and unwearied labors, are worthy of all commendation.

Respectfully submitted by

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coasts of the United States during the surveying season of 1857–'58.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I.				
From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.	No. 1	Primary triangulation, astronomical and magnetic observations.	A. D. Bache, Superintendent; Geo. W. Dean, assistant; Lieut Thomas Wilson, U. S. A., assistant; A. T. Mosman, R. E. Evans, A. W. Thompson, and H. W. Bache, aids.	Mount Humpback, Hancock county, Me., occupied, and observations completed for geodetic purposes. Determination of azimuth at the astronomical station, the latitude, and the magnetic elements. (See also Sections V, VI, and VIII.)
	2	Reconnaissance	C. O. Boutelle, assistant; W. S. Edwards, sub-assistant; C. H. Boyd, aid, (part of season.)	Ranges established for determining the primary angles meeting at Humpback geodetic station, Me. Reconnaissance for the secondary triangulation of Penobscot bay, Me. (See also Section V.)
	3	Secondary triangulation.	Stephen Harris, sub-assistant	Triangulation of the lower part of Penobscot bay, Me., including stations on the islands in the entrance, carried northward towards the primary line "Ragged Mount—Isle au Haut." (See also Section VIII.)
	4	Reconnaissance and secondary triangulation.	F. P. Webber, sub-assistant; Benjamin Huger, jr., sub-assistant; Julius Kincheloe, aid.	Stations selected and triangulations carried over Boothbay harbor and Damariscotta river, and eastward as far as Muscongus bay and Manhegan island. (See also Sections V and VI.)
	5	Topography	I. Hull Adams, assistant	Shore lines of the Sheepscot river, Me., traced from its entrance to Wiscasset, and detailed plane-table survey made of the vicinity of the Edgecombe Quarries. (See also Section III.)
	6	Topography	R. M. Bache, assistant; W. S. Gilbert, sub-assistant.	Details of topography completed on the shores of Kennebec river from its entrance upward above Bath, Me., and including the shores of Merrymeeting bay. (See also Section VIII.)
	7	Topography	A. W. Longfellow, assistant; A. S. Wadsworth, assistant; C. H. Boyd, aid, (part of season.)	Contour lines and topographical features of the environs of Portland, Me., Cape Elizabeth and its vicinity, and the neighboring islands, completed for the map of Portland harbor. (See also Sections IV and V.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I—(Continued)	No. 8	Topography	A. M. Harrison, assistant; W. H. Dennis, sub-assistant.	Plane-table survey of the western shore of Massachusetts bay, completed from the lower confines of Scituate southward to the limit of finished work above Plymouth harbor, and including the shores of North river and its tributaries. (See also Section V.)
	9	Hydrography	Lieut. Comg. Jas. H. Moore, U. S. N., assistant.	Soundings completed in the Sheepscot river from its entrance to Wiscasset, Me. Hydrography of Kennebec river extended above Bath, Me., to include Merrymeeting bay. Tides observed in both. (See also Sections II and V.
	10	Hydrography	Lieut. Comg. W. G. Temple, U. S. N., assistant.	Hydrography of the space surrounding Half-way Rock, completing that of the entrance to Casco bay, Me. (See also Sections II and VI.)
	11	Hydrography	Lieut. Comg. Alex. Murray, U. S. N., assistant.	In-shore soundings extended from Cape Porpoise, Kennebunkport, Me., abreast of Portsmouth harbor, N. H., and southeastward to the Isles of Shoals. Dangers developed within those limits. Re-examination of Lynn harbor, Mass. Off-shore line of soundings carried north of the latitude of Monomoy light and others run to the northward and eastward of Cape Ann, Mass. (See also Sections II and IV.)
	12	Hydrography	Lieut. Comg. W. G. Temple, U. S. N., assistant.	Examination of the positions and designation of the buoys in Salem harbor, Mass, and hydrography verified in several localities of Boston harbor. (See also Sections II and VI.)
		Tidal observations		Series continued at the Charlestown navy yard, Mass., with the self-registering tide-gauge.
		Inspection	A. D. Bache, Superintendent.	
SECTION II. From Point Judith to Cape Henlopen, includ'g the coast of Connecticut, New York, and New Jersey, and shore of Pennsylvania and Delaware.	No. 1	Astronomical, telegraphic, and magnetic observations.	Dr. B. A. Gould, jr., assistant; G. W. Dean, assistant; Edward Goodfellow, sub-assistant; A. T. Mosman, aid.	For exchange of star signals to determine the difference of longitude between New York city and Albany; determination of the magnetic elements at Albany, and latitude observations at Rutherford Observatory, New York city. (See also Sections I and VIII.)
	2	Triangulation and topography.	Edmund Blunt, assistant; Lieut. A. H. Seward, U. S. A., assistant; Lieut. W. R. Terrill, U. S. A., assistant; C. Fendall, sub-assistant.	Triangulation of Hudson river carried from Tunnel Point, northward, to the city of Hudson; points determined for the sounding of Rondout and Esopus creeks, and plane-table surveys made of their shores.
	3	Topography	H. L. Whiting, assistant; C. Rockwell, aid.	Details of topography of the north shore of Long Island filled in, from Little Neck bay, westward, to Hunter's Point. (See also Section V.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION II—(Continued.)	No. 4	Topography	F. W. Dorr, sub-assistant	Plane-table details of the shores of Newark bay and of the western shore of Arthur Kill, from Newark, southward, to Perth Amboy, N. J. (See also Section VI.)
	5	Hydrography	Lieutenant Commanding W. G. Temple, U. S. N., assistant.	Determination of the position of the Luddington rocks, near New Haven light-house, Conn. (See also Sections I and VI.)
	6	Hydrography	Lieutenant Commanding Jas. H. Moore, U. S. N., assistant, (part of season;) Lieutenant Commanding Alex. Murray, U. S. N., assistant.	Hydrography of Hudson river extended above Fishkill, and soundings made at the entrances of Rondout and Esopus creeks. (See also Sections I, IV, and V.)
	7	Tidal currents	H. Mitchell, assistant; G. B. Vose and W. H. Gardner, aids.	Observations on the currents of East river, near Throg's neck, and on those of New York harbor, the lower bay, and beyond the bar. Lines of levels for tidal reductions run on the bank of Hudson river.
		Tidal observations		Series continued with self-registering tide-gauge at Governor's island, (New York harbor,) and with the box-gauge at Brooklyn, L. I. Partial series observed at Sandy Hook, N. J.
SECTION III. From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and Virginia.	No. 1	Secondary triangulation.	Lieutenant J. P. Roy, U. S. A., assistant.	Extension of work from Leonard's creek, upwards, beyond Benedict, to the vicinity of Nottingham, completing the triangulation of Patuxent river, Md.
	2	Secondary triangulation.	John Farley, assistant; S. A. Wainwright, sub-assistant.	Triangulation of the lower part of Potomac river, Va., connected with the primary work on Chesapeake bay, and extended upward to Piney Point.
	3	Topography	Charles Ferguson, sub-assistant.	Plane-table survey of Chincoteague island completed, with details of the coast in the vicinity of the boundary line between Maryland and Virginia. (See also Section V.)
	4	Topography	John Seib, assistant	Topography from Bigler's mill to the junction of the Pamunkey and Mattaponi, completing the survey of York river, Va. Plane-table work extended on the shores of Mobjack bay, upwards, to include East river, Va. (See also Section V.)
	5	Topography	I. Hull Adams, assistant; S. A. Wainwright, sub-assistant, (part of season;) G. U. Mayo, aid.	Survey of the city of Richmond, Va., to complete the map of James river. (See also Section I.)
	6	Hydrography	Commander W. T. Muse, U. S. N., assistant.	Hydrography completed in Fishing bay, Nanticoke river, Monie bay, and Manokin river, and connected with that of Tangier sound, Md. (See also Section IV.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION III—(Continued.)	--------	Tidal observations.	------------------------	Observations continued with the self-registering tide-gauge at Old Point Comfort, and a series commenced at the Washington navy yard, D. C.
SECTION IV.				
From Cape Henry to Cape Fear, including part of the coast of Virginia and the coast of North Carolina.	No. 1	Secondary triangulation and topography.	J. J. S. Hassler, assistant, (part of season;) F. R. Hassler, aid.	For connecting the coast triangulation below Cape Henry with the main work on Chesapeake bay. Plane table survey of the tract adjacent to Back bay in the vicinity of the boundary between Virginia and North Carolina.
	2	Triangulation -----	A. S. Wadsworth, assistant..	Selection and marking of sites for bases near Cape Lookout, south of the entrance to Bogue sound, in the vicinity of New River inlet, near New Topsail inlet, at Masonboro' inlet, and near Cape Fear, to verify the coast triangulation of North Carolina. (See also Section I.)
	3	Topography -- ----	John Mechan, sub assistant.	Plane-table survey from Stump inlet southward to New inlet, completing the topography of the coast of North Carolina between Cape Lookout and Cape Fear. (See also Section VI.)
	4	Hydrography -----	Commander W. T. Muse, U. S. N., assistant.	Hydrography of Pamplico sound abreast of Cape Hatteras extending northward beyond Gull island, and westward to the limits of previous work near Ocracoke inlet; soundings in Pamplico below Ocracoke entrance continued to the meridian of Harbor island. (See also Section III.)
	5	Hydrography -----	Lieutenant Commanding C. R. P. Rodgers, U. S. N., assistant, (part of season;) Lieutenant Commanding Alexander Murray, U. S. N., (part of season.)	In-shore hydrography continued westward along the coast of North Carolina from Beaufort entrance to a point below Bogue inlet. Off-shore soundings run in the same locality and tides observed. (See also Sections I and II.)
SECTION V.				
From Cape Fear to St. Mary's river, including the coast of South Carolina and Georgia.	No. 1	Secondary triangulation and topography.	C. P. Bolles, assistant; O. Hinrichs, aid.	Topographical resurvey of the shores of the Cape Fear entrances for commissioners. Triangulation and topography of the coast completed between Lockwood's Folly and Shallotte inlet, North Carolina; and plane-table work extended westward to Tubbs' inlet.
	2	Primary and secondary triangulation.	C. O. Boutelle, assistant; H. S. Du Val, aid; W. S. Edwards, aid.	Connection of the base on South island, Winyah bay, South Carolina, with Edisto base, completed by secondary triangulation on the coast of South Carolina, from Winyah entrance southward and westward to Cape Roman light. Primary stations established on Hutchinson's island and Hunting island for extending the work southward. Connexion made between the Edisto and Savannah river bases through secondary work at the head of Calibogue sound and tertiary triangulation of Beaufort river, South Carolina. (See also Section I.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION V—(Continued.)	No. 3	Secondary and tertiary triangulation.	Lieut. A. W. Evans, U. S. A., assistant; F. P. Webber, aid; G. U. Mayo, aid, (part of season.)	Triangulation completed on Ossabaw and St. Catharine's sounds, Georgia, including Great and Little Ogeechee rivers and other tributaries, connecting the work from Savannah river with the preliminary base on Sapelo island. (See also Section I.)
	4	Topography	H. L. Whiting, assistant; C. Rockwell, aid, (part of season)	Complete resurvey of the shores of Winyah bay, South Carolina, upwards from its entrance, including the adjacent outer coast, part of South island, the Marsh islands in the bay, and the shores of Georgetown harbor to the junction of the Pedee and Waccamaw rivers, Rabbit and Hare islands, and the city of Georgetown. (See also Section II.)
	5	Topography	C. O. Boutelle, assistant; W. S. Edwards, aid.	Resurvey of the shores of Charleston harbor, South Carolina, including the city of Charleston, opposite shores of Ashley and Cooper rivers, Sullivan's island, Shute's Folly, Drum island, and the southern shore of the harbor extending eastward to Morris' island. (See also Section I)
	6	Topography	John Seib, assistant; C. Rockwell, aid, (part of season.)	Outer shore and interior of Morris' island and Folly island resurveyed southward from Charleston harbor, South Carolina. Topography continued on the northern side of St. Helena sound, embracing the greater part of Hutchinson's island and the adjacent shores of Ashepoo river. (See also Section III.)
	7	Topography	A. M. Harrison, assistant; Charles Ferguson, sub-assistant, W. H. Dennis, aid.	Topography of Ossabaw sound, Ga., completed, including the shores of the Ogeechee and Vernon rivers, with numerous tributaries and dependencies; the shores of the "inland passage;" adjacent parts of Great and Little Wassaw, Skiddaway, Ossabaw, and other islands, and Raccoon key. (See also Section I)
	8	Topography	A. W. Longfellow, assistant; Clarence Fendall, aid.	Completion of the plane table survey of Sapelo sound and river to Sutherland's bluff. Survey of Brunswick city, Ga., and the environs, with details of the vicinity of Turtle river, and the topography of the interior of Jekyl island. (See also Section I.)
	9	Hydrography	Lieutenant Commanding T. B. Huger, U. S. N., assistant.	Resurvey of the entrances and bars of Cape Fear river, for commissioners. Re-examination of Maffitt's channel, Charleston harbor; and off-shore hydrography between Cape Roman, S. C., and Fernandina, Fla.
	10	Hydrography	Lieutenant Commanding James H. Moore, U. S. N., assistant.	Hydrography completed in Sapelo sound and river, extending from inside the bar upwards to Sutherland's bluff. (See also Sections I and II.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION V—(Continued.)	--------	Tidal observations	------------------------	Series of observations continued with the self-registering tide-gauge near the custom-house at Charleston, S. C.
		Inspection -------	A. D. Bache, Superintendent.	
SECTION VI.				
From St Mary's river to St. Joseph's bay, including the eastern and part of the western coast of Florida peninsula, with the Florida reefs and keys.	No. 1	Triangulation -----	Captain J. H. Simpson, U. S. Topographical Engineers, assistant, (part of season ;) Captain M. L. Smith, U. S. Topographical Engineers, assistant ; J. A. Sullivan, sub-assistant ; F. W. Alexander, aid, (part of season ;) R. M. Stiles, aid.	Triangulation for the air-line measurement between Fernandina and Cedar keys, Fla., continued from Dunn's creek southward and westward to Padgett's Station, and opening of lines of sight beyond to Trail ridge.
	2	Triangulation -----	Benjamin Huger, jr., sub-assistant ; Rufus King, jr., aid.	From St. John's river entrance, southward along the eastern coast of Florida peninsula, to Diego plains. (See also Section I.)
	3	Triangulation -----	Lieutenant A. H. Seward, U. S. Army, assistant ; C. B. Baker, aid.	Triangulation carried from the Cape Sable base, Florida peninsula, southward and eastward, and connected at Lignum Vitæ key with general work on the main line of the Florida reef. (See also Section II.)
	4	Triangulation -----	Lieutenant J. C. Clark, U S. A., assistant ; C. W. Duval, aid.	Preliminary base measured on Sanibel island, coast of Florida, and triangulation carried northward over San Carlos bay as far as Boca Grande and Captiva Pass, including the entrance to Charlotte harbor.
	5	Topography ------	John Mechan, sub-asssistant.	Plane table survey of the coast of Florida, extending from St. John's river southward to Diego Plains, and including the shores of Pablo creek. (See also Section IV.)
	6	Topography ------	F. W. Dorr, sub-assistant ; James Gilliss, aid.	Inside shore of Long Island Florida reef, opposite to Key Largo, traced to Taverniet creek ; survey of the southern part of Long key, the Conch keys, Duck key, the Channel keys, Grassy key, the Crawl keys, and a part of Fat Deer key, and fast land thereon marked in quarter sections for the General Land Office. (See also Section II.)
	7	Topography ------	C. T. Iardella, sub-assistant; J. S. Bradford, aid.	Topography of Plantation or Windly's key, Vermont and Shell keys, Upper and Lower Matecumbe, the greater part of Long key, and small patches inside of the general range, with quarter section markings for the General Land Office. (See also Section VII.)
	8	Topography ------	F. W. Dorr, sub-assistant ; James Gilliss, aid.	Shore-line of the southern entrance to Charlotte harbor, Fla., including the eastern side of San Carlos bay from Mantanzas Pass northward to Sword Point, the entrance of Caloosahatchee river, the eastern half of Sanibel island, and the southern part of Pine island. (See also Section II.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VI—(Continued.)	No. 9	Hydrography ----	Lieut. Comg. W. G. Temple, U. S. N., assistant.	Soundings on the Florida reef extended from Bahia Honda northward and eastward to Key Vacas. (See also Section I and Gulf Stream.)
	10	Tidal observations -	G. Würdemann ----------	Series continued with self-registering gauges at Fort Clinch, Cape Florida, Indian key, Key West, and Tortugas, Florida reefs, and observations commenced at Charlotte harbor and Egmont key, (Tampa.)
		Inspection --------	A. D. Bache, Superintendent.	
GULF STREAM -------	--------	Deep-sea soundings	Commander B. F. Sands, U. S. N., assistant; Lieut. Comg. W. G. Temple, U. S. N., assistant.	Sections from Key West and the Tortugas to Havana, with determinations of the temperature at various depths. Observations on the counter current in the stream south of Cape Hatteras. (See also Sections I and VIII.)
SECTION VII.				
From St. Joseph's bay to Mobile bay, including part of western coast of Florida and the coast of Alabama.	No. 1	Triangulation- ----	G. H. Bagwell, sub-assistant; M. O. Hering, aid.	Triangulation of the western coast of Florida peninsula continued from Crystal river southward to Homosassa Point.
	2	Triangulation- ----	S. C. McCorkle, sub-assistant; A. W. Thompson, aid.	Extension of work from Southwest cape, Fla., over Alligator harbor and Dog island, and westward to its previous limits near Apalachicola, completing the triangulation of St. George's sound. Reconnaissance made for continuing the work eastward to St. Mark's.
	3	Astronomical observations, triangulation, and topography.	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. H. Boyd, aid.	Triangulation of the Lagoon westward from the entrance to Pensacola habor, and of Escambia bay from its entrance northward to Live Oak Point. Observations for latitude, azimuth, and the magnetic elements at Pensacola, and plane-table survey within the limits of the triangulation. (See also Section VIII.)
	4	Topography -- ----	N. S. Finney, sub-assistant; J. L. Tilghman, aid.	Topography of the western coast of the Florida peninsula continued from Crystal river entrance southward, and including the shores of Crystal and Salt Water bays, with the adjacent shell and coral reefs.
	5	Topography -- ----	C. T. Iardella, sub-assistant; J. S. Bradford, aid.	Shore-line and part of the interior of St. James' island, St. George's sound, Fla., from Ocklokonee Point and Southwest cape westward to complete work near Crooked river, and including the shores of Alligator harbor. (See also Section VI.)
	6	Topography -- ----	George D. Wise, assistant; F. F. Nes, aid.	Topography completed on the main shore of St. George's sound, Florida; from Apalachicola river eastward beyond Crooked river, and westward to Indian Pass, including plane-table surveys of Dog island and St. Vincent island.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operation.
SECTION VII—(Continued.)	No. 7	Hydrography	Lieutenant Commanding J. K. Duer, U. S. N., assistant.	Preliminary investigation of the capacity of a new channel leading into St. George's sound, Fla., past the east end of Dog island. Hydrography of the east and west passes into the sound, including their approaches and bars, and the development of adjacent shoals. (See also Section IX.)
		Tidal observations		Series of observations commenced with self-registering tide-gauges at Cedar keys and Pensacola.
SECTION VIII.				
From Mobile bay to Vermilion bay, including the coast of Alabama and Mississippi and part of the coast of Louisiana.	No. 1	Astronomical, telegraphic, and magnetic observations.	G. W. Dean, assistant; Edward Goodfellow, sub-assistant; J. Kincheloe, aid; A. T. Mosman, aid.	For telegraphic difference of longitude between Mobile and New Orleans. Observations for latitude and for the magnetic elements at New Orleans. (See also Sections I and II.)
	2	Primary triangulation.	J. E. Hilgard, assistant; Stephen Harris, sub-assistant; R. E. Halter, aid; Henry W. Bache, aid.	Primary triangulation of Mississippi sound carried westward to the meridian of New Orleans and connected with stations in that city. (See also Section I.)
	3	Astronomical observations and triangulation.	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant; C. H. Boyd, aid; R. E. Halter, aid, (part of season.)	Measurement of a preliminary base and triangulation of the Mississippi delta from the mouths of the passes upwards to their junction. Observations for latitude and azimuth, and for local time in connection with exchanges of telegraph signals between the astronomical station and New Orleans. (See also Section VII.)
	4	Reconnaissance	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant.	Reconnaissance for extending the triangulation going westward from Atchafalaya, over Côte Blanche bay (west) and Marsh island. (See also Section VII.)
	5	Topography	W. S. Gilbert, sub-assistant; R. E. Evans, aid.	Survey of the neck of land between Lake Borgne and Lake Pontchartrain, bounded by West Pearl river on the northeast and by Chef Menteur on the southwest, including the Rigolets, the shore-line of Lake St. Catharine and its numerous connections with the lakes. (See also Section I.)
	6	Hydrography	Commander B. F. Sands, U. S. N., assistant.	Hydrographic reconnaissance of Lake Borgne, in the vicinity of Bayou Dupre. Soundings completed at the entrance and in Atchafalaya bay, La., east of the meridian of Point au Chevreuil. Line of soundings, run from the Atchafalaya entrance eastward to the Mississippi delta, and from thence to the Tortugas bank, with observations for deep-sea temperatures. (See also Gulf Stream.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IX.				
From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana and the coast of Texas.	No. 1	Reconnaissance for triangulation.	S. A. Gilbert, assistant; Charles Hosmer, aid.	Minute reconnaissance of the coast of Texas from Matagorda entrance to Aransas pass, including the shores of Espiritu Santo, San Antonio, and Aransas bays. Stations selected for the triangulation, and preliminary plane-table surveys, soundings, and tidal observations made to facilitate future progress
	2	Topography	M. Seaton, sub-assistant; T. C. Bowie, aid.	Plane-table survey of the shores of Lavaca bay completed, including the entrances of its tributaries and the town of Lavaca.
	3	Hydrography	Lieutenant Commanding J. K. Duer, U. S. N., assistant.	Hydrographic reconnaissance of the approaches, bar, and channel of the Brazos river to Velasco, Tex Series of soundings between the Mississippi delta and Galveston. (See also Section VII.)
SECTION X.				
Western coast of the United States, from the southern boundary to the 42d parallel, including the coast of California.	No. 1	Primary and secondary triangulation.	W. E. Greenwell, assistant; P. C. F. West, aid, (part of season.)	Primary work on the coast of Santa Barbara channel, Cal., completed westward to San Buenaventura, and secondary triangulation made for the survey of the island of San Miguel.
	2	Primary and secondary triangulation.	G. A. Fairfield, assistant, (part of season;) C. B. Ellis, aid, (part of season.)	Observations nearly completed at the primary station on Tomales bay, Cal. Triangulation of Petaluma creek completed, including its entrance into San Pablo bay, Cal., and the town of Petaluma.
	3	Triangulation and topography.	Aug. F. Rodgers, sub-assistant, (part of season;) David Kerr, aid.	Triangulation made on Napa creek, from San Pablo bay, Cal., to the town of Napa, and the plane-table survey completed.
	4	Topography	W. M. Johnson, sub-assistant; C. M. Bache, aid.	Plane-table survey extended eastward, around, and including Point Duma, Cal., and topography commenced on Santa Cruz island, (Santa Barbara channel.)
	5	Topography	A. F Rodgers, sub-assistant, (part of season;) David Kerr, aid.	Detailed resurvey of San Francisco city and its environs completed.
	6	Hydrography	Lieutenant Commanding Rich'd M. Cuyler, U. S. N, assistant.	Off-shore soundings commenced at the approaches of the Golden gate. Supplementary hydrography executed along the front of San Francisco city, and additional soundings made in the southeastern part of San Francisco bay. Tides observed at three stations.
	7	Tidal observations	Lieut G. H. Elliot, United States engineers.	Observations continued with self-registering tide gauges at San Diego, Cal., and at Fort Point, near San Francisco. (See also Section XI.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION XI.				
Western coast of the United States, from the 42d parallel to the northern boundary, including the coast of Oregon and Washington Territories.	No. 1	Triangulation and topography.	James S. Lawson, sub-assistant; P. C. F. West, sub-assistant, (part of season.)	Reconnaissance, erection of signals, and triangulation in the lower part of the Gulf of Georgia, W. T. Plane-table surveys of the islands lying at the northern entrances of Rosario strait and Canal de Haro, forming the southern boundary of the Gulf of Georgia.
	2	Hydrography	Commander James Alden, U. S. N., assistant.	Soundings executed in the southeastern part of the Gulf of Georgia, W. T., and general duty for the Department of State, connected with the operations of the commissioner on the northwestern boundary of the United States.
	3	Tidal observations.	Lieut. G. H. Elliot, United States engineers.	Series continued with the self-registering gauge at Astoria, Oregon. (See also Section X.)

APPENDIX No. 2.

List of Army officers on Coast Survey duty March 1, 1858.

Officers.	Rank.	Date of attachment.
W. R. Palmer	Captain topographical engineers	November 17, 1857
Martin L. Smith	Captain topographical engineers	December 9, 1856
Joseph C. Clark, jr	First lieutenant 4th artillery	January 7, 1854
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
John C. Tidball	First lieutenant 2d artillery	September 6, 1854
Augustus H Seward	First lieutenant 5th infantry	December 11, 1851
Edward B. Hunt	First lieutenant engineers	May 5, 1851
Rufus Saxton	First lieutenant 4th artillery	December 25, 1855
James P. Roy	First lieutenant 2d infantry	October 7, 1853
Thomas Wilson	First lieutenant 5th infantry	May 26, 1857
William Myers	First lieutenant 9th infantry	September 10, 1857

APPENDIX No. 3.

List of Army officers on Coast Survey duty September 1, 1858.

Officers.	Rank.	Date of attachment.
T. J. Cram	Captain topographical engineers	March 26, 1858
W. R. Palmer	Captain topographical engineers	November 17, 1857
Martin L. Smith	Captain topographical engineers	December 9, 1856
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
John C. Tidball	First lieutenant 2d artillery	September 6, 1854
Augustus H. Seward	First lieutenant 5th infantry	December 11, 1851
Edward B. Hunt	First lieutenant engineers	May 5, 1851
Rufus Saxton	First lieutenant 4th artillery	December 25, 1855
James P. Roy	First lieutenant 2d infantry	October 7, 1853
William R. Terrill	First lieutenant 4th artillery	March 17, 1858
Thomas Wilson	First lieutenant 5th infantry	May 26, 1857
William Myers	First lieutenant 9th infantry	September 10, 1857

APPENDIX No. 4.

List of Navy officers on Coast Survey duty March 1, 1858.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
	Office-work, Section I	F. A. Roe	Lieutenant	February 21, 1856
	Office-work, Section IV	W. T. Muse	Commander	February 27, 1857
		R. D. Minor	Lieutenant	January 15, 1858
	Office-work, Section V	J. N. Maffitt	do	May 9, 1843
	Office-work	James Alden	Commander	May 18, 1849
Steamer Bibb	Section IV	C. R. P. Rodgers	Lieutenant commanding	July 7, 1855
		K. R. Breese	Lieutenant	July 10, 1855
		Henry Wilson	do	December 8, 1856
		A. E. K. Benham	do	February 12, 1857
		De Grasse Livingston	do	July 8, 1856
		H. O. Mayo	Passed assistant surgeon	December 10, 1856
Schooner Crawford	Section V	Thomas B. Huger	Lieutenant commanding	October 12, 1857
Schooner Wave	Section V	James H. Moore	do	January 22, 1857
		George H. Bier	Lieutenant	February 10, 1857
		B. E. Hand	do	December 1, 1857
Steamer Corwin	Section VI	W. G. Temple	Lieutenant commanding	June 5, 1855
		J. H. Rochelle	Lieutenant	July 11, 1855
		W. M. Gamble	do	September 18, 1855
		W. McGunnegle	do	December 8, 1857
Steamer Vixen	Sections VII and IX	John K. Duer	Lieutenant commanding	August 1, 1855
		John P. K. Mygatt	Lieutenant	February 25, 1857
Steamer Walker	Section VIII	B. F. Sands	Commander	May 14, 1850
		John Irwin	Lieutenant	October 15, 1856
		W. T. Hord	Assistant surgeon	November 3, 1857
Steamer Active	Sections X and XI	R. M. Cuyler	Lieutenant commanding	June 20, 1845
		S. S. Bassett	Lieutenant	March 17, 1849
		P. C. Johnson	do	July 20, 1854
		James Suddards	Passed assistant surgeon	July 1, 1857

APPENDIX No. 5.

List of Navy officers on Coast Survey duty September 1, 1858.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.	
	Office	B. F. Sands	Commander	May	14, 1850
		R. M. Cuyler	Lieutenant	June	20, 1845
Steamer Bibb	Section I	Alexander Murray	Lieutenant commanding	April	23, 1858
		K. R. Breese	Lieutenant	July	10, 1855
		Henry Wilson	do	December	8, 1856
		A. E. K. Benham	do	February	12, 1857
		H. O. Mayo	Passed assistant surgeon	December	10, 1856
Steamer Corwin	Section I	W. G. Temple	Lieutenant commanding	June	5, 1855
		J. H. Rochelle	Lieutenant	July	11, 1855
		W. McGunnegle	do	December	8, 1857
		H. M. Garland	do	May	17, 1858
Schooner Varina	Section I	James H. Moore	Lieutenant commanding	January	22, 1857
		George H. Bier	Lieutenant	February	10, 1857
		Bayard E. Hand	do	December	1, 1857
Steamer Vixen	Section II	John K. Duer	Lieutenant commanding	August	1, 1855
		J. P. K. Mygatt	Lieutenant	February	25, 1857
Schooner Crawford	Section III	T. B. Huger	Lieutenant commanding	October	12, 1857
Steamer Hetzel	Section IV	W. T. Muse	Commander	February	27, 1857
		Greenleaf Cilley	Lieutenant	April	9, 1858
Steamer Active	Section XI	James Alden	Commander	May	18, 1849
		W. Gwathmey	Lieutenant	May	20, 1858
		P. C. Johnson	do	July	20, 1854
		John G. Mitchell	do	June	30, 1858
		James Suddards	Passed assistant surgeon	July	1, 1857

APPENDIX No. 6.

List of information furnished by the Coast Survey during the year 1857–'58, *under authority of the Treasury Department.*

Date.		To whom communicated.	Information communicated.
1857.			
Nov.	2	Hon. D. L. Yulee	Tracing of part of Amelia river, Florida.
	4	Prof. A Guyot	Measurement of height of Mount Washington, N. H.
	10	Capt. A. A. Humphries, Top. Engineers	Data relative to tides at the Belize, La.
	11	Astronomical Journal	Results of observations on occultations of the Pleiades.
	17	Thomas Jekyll	Data for projecting maps between latitude 14° and 20°.
	25	Capt. W. F. Reynolds, Top. Engineers	Tracing of Cape May from steamboat landing to the village, New Jersey.
Dec.	5	G. W. Blunt, esq	Tracing of hydrography in vicinity of Cape Ann, Mass.
	6	do	Tracing of off-shore soundings, coast of Massachusetts.
	6	Light-house Board	Tracing of hydrography off Cape Ann, Mass.
	6	Portland Board of Trade	Tracing showing bank off Union wharf, Portland harbor, Me.
	22	Governor of Massachusetts	Developments of resurvey of Provincetown harbor, Mass.
	22	Capt. H. W. Benham, Corps of Engineers	Tracing of resurvey of Provincetown harbor, Mass.
	22	Governor of New York	Tidal and current observations made in and near Hell Gate and in Hudson river, N. Y.
	26	J. B. and D. E. Calver, esqs	List of geographical positions in the vicinity of New York city.
	31	Portland Board of Trade	Tracing of "Jordan's rock," entrance to Portland harbor, Me.
1858.			
Jan.	19	Col. Harvey Brown, U. S. A	Tracing of Fortress Monroe and vicinity, Va.
	23	P. Barnes, esq	Latitude and longitude of Mount Washington, N. H.
	31	Northwestern Boundary Commissioner	Tracing of reconnaissance of the Gulf of Georgia, W. T.
Feb.	2	G. W. Blunt, esq	Certain latitudes and longitudes between Charleston and Tybee light, S. C.
	3	Gen. John A. Quitman	Tracing of Ship Island harbor, Miss.
	12	Northwestern Boundary Commissioner	Tracing of Semiahmoo bay, W. T.
	20	G. W. Blunt, esq	Tracing of off-shore hydrography from Charleston, S. C., to Savannah, Ga.
	20	do	Tracing of off shore soundings from Newburyport to Monomoy, Massachusetts.
	20	do	Tracing of hydrography from Gurnett Point to Scituate, Mass.
	25	Hon. John A. Dix	Tracing of Byram river entrance, N. Y. and Conn.
March	6	Stephen Taber, esq	Tracing of topography of part of Currituck sound, N. C.
	10	Engineer Bureau	Tidal and magnetic data of Kennebec river entrance, Me.
	19	Capt. G. W. Cullum, Corps of Engineers	Tracing of shore-line of Sullivan's island, showing position of buoys in Maffitt's channel, Charleston harbor, S. C.
	22	G. W. Blunt, esq	Tracing of hydrography from Charleston to Cape Roman, S. C.
	29	Committee on Cape Fear river	Tracings of Cape Fear entrance, N. C.
	29	Theodore Sedgwick, esq	Tracing showing wharf-line of Wallabout bay, East river, N. Y.
	30	S. J. Martenet, esq	Tracing from reduction, $\frac{1}{80000}$, of western shore of Chesapeake bay from Middle river to Patuxent river entrance.
April	6	Hon. S. R. Mallory	Tracing of Pensacola bay, Fla.
	7	Light-house Board	Tracing of entrance to San Francisco bay, Cal.
	8	Charles Copley, esq	Tracing of hydrography of Hatteras inlet, N. C.
	8	do	Tracing of hydrography of Ocracoke inlet, N. C.
	9	Lieut. W. H. Stevens, Corps of Engineers	Tracing of hydrography of Matagorda bay, Texas.
	13	L. McKay, esq	Tracing of Pass Cavallo, entrance to Matagorda bay, Texas.
	17	Prof O. M. Mitchel	Certain information relative to personal equations.
	21	W. H. Denning, esq	Tracing of hydrography of Hudson river from Peekskill to Newburgh, N. Y.
May	8	Maj. J. G. Barnard, Corps of Engineers	Tracing of shore-line of Sandy Hook, N. Y.
	13	Prof H L. Smith	Specimens of bottom taken in soundings made by the Coast Survey.
	15	Contractors on improvement of Corpus Christi bay.	Tracing showing Ayer's and Oyster reefs, coast of Texas.
	17	Capt. G. W. Cullum, Corps of Engineers	Tracing of resurvey of Maffitt's channel, Charleston harbor, S. C., in 1858.
	18	Chamber of Commerce, Charleston, S. C	Tracing of resurvey of Maffitt's channel, Charleston harbor, S. C., in 1858.
	20	A. M. Edwards, esq	Specimens of bottom taken in deep-sea soundings by the Coast Survey.
	24	Collector of Customs, Puget's Sound, W. T	Tracing of Semiahmoo bay, W. T.
	31	Light-house Board	Tracing from reduction, $\frac{1}{30000}$, of Pensacola bay, Fla.
June	2	F. A. Conkling, esq	Expenditures of the Coast Survey, and facts on insurance, upon Florida reefs.

APPENDIX No. 6—Continued.

Date.		To whom communicated.	Information communicated.
1858.			
June	2	A. F. Ravenel, esq	Results of observations made upon the depth of water at Cedar Keys, Florida.
	14	Light-house Board	Tracing of Galveston bay entrance, Texas.
	15	do	Tracing of hydrography of Clopper's bar, Galveston bay, Texas.
	15	do	Tracing of shore-line of Pearl river entrance and vicinity, Miss.
	15	Prof. J. L. Riddell	Description of meridian line established at New Orleans, La.
	16	W. H. Davidge, esq	Tracing showing position of rock near "The Brothers," San Francisco bay, Cal.
	16	do	Tracing showing reef near Contra Costa, San Pablo bay, Cal.
	18	Hon. E. C. Cabell	Tracing of topography of Dog island and St. George's sound, in vicinity of Crooked river, Fla.
	19	Messrs. Sartwell and Duncan	Tracing of Matagorda entrance and bar, Texas.
	22	Richard A. Stewart, esq	Tracing of reconnaissance of southwestern part of Lake Borgne, Louisiana.
July	12	Engineer Bureau	Tracing of part of Delaware bay, showing the breakwater erected by the United States government.
	22	G. W. Blunt, esq	Tracing of hydrography off coast of North Carolina in vicinity of Bogue inlet.
	22	Col. C. Schlatter	Tracing of St. Simon's sound and Brunswick harbor, Ga.
Aug.	7	Capt. W. B. Franklin, Top. Engineers	Tracings from comparative charts of Cape Fear river entrances, North Carolina.
	24	L. M. Rutherford, esq	Result of observations for latitudes made in New York city by the Coast Survey.
Sept.	3	Virginia and Maryland Boundary Commissioners.	Tracing of Smith's Point and vicinity, Va.
	3	do do	Tracing of south end of Smith's island, Md.
	3	do do	Tracing of topography north of entrance to Pocomoke sound, Maryland.
	10	Board of Engineers, U. S. A	Tracing of part of Galveston bay, Texas.
	15	Governor of Massachusetts	Tracing of northern extremity of Cape Cod, Mass.
	16	A. G. Thompson, esq	Tracing of Fire Island inlet and vicinity, N. Y.
Oct.	22	Col. T. J. Lee	Tracing of topography of Chincoteague island and vicinity, Va.
	22	do	Tracing of topography of part of Pocomoke sound, Md. and Va.

APPENDIX No. 7.

List of capes, headlands, islands, harbors, and anchorages, on the western coast of the United States, of which either topographical, hydrographic, preliminary, or complete surveys have been made, or maps, charts, or sketches issued.

Names in geographical order.	Character of survey.	Published.
CAPES AND HEADLANDS.		
Point Loma	Complete survey	Sketch
Point Pedro	do	do
Point Fermin	do	do
Point Duma	Topographical survey	
Point Hueneme	Topographical and hydrographic survey	
Buenaventura Mission	do do	
Point Conception	Topographical survey	Sketch
Point Piños	Complete survey	do
Point Año Nuevo	Topographical and hydrographic survey	do
Pigeon Point	do do	
Point San Pedro	Complete survey	
Point Lobos	do	Sketch
Point Bonita	do	do
Ballenas Bluff	do	
Point Reyes	do	Sketch
Point Adams	do	do
Cape Disappointment	do	do
Cape Flattery	Topographical survey	do
ISLANDS.		
Los Coronados islands	Topographical survey	
Anacapa island	Complete survey	Map
Santa Cruz island, east end of	do	Map
Farallones islands	Topographical survey	Sketch
Alcatraz island	Complete survey	do
Yerba Buena island	do	do
Angel island	do	do
Mare island	do	do
Sand island	do	do
Smith's island	do	do
Cypress island, part of	Topographical survey	
HARBORS AND ANCHORAGES.		
San Diego harbor	Complete survey	Preliminary chart
San Clemente anchorage, southeast end of island	Hydrographic survey	Sketch
San Clemente anchorage, northeast end of island	do	do
Catalina harbor	do	do
San Pedro harbor	Topographical and hydrographic survey	do
Smugglers' cove, Santa Cruz island	Complete survey	do
Prisoners' harbor, Santa Cruz island	Hydrographic survey	do
Cuyler's harbor, island of San Miguel	do	do
Santa Barbara anchorage	Complete survey	do

APPENDIX No. 7—Continued.

Names in geographical order	Character of survey.	Published.
HARBORS AND ANCHORAGES—Continued.		
Coxo harbor	Topographical survey	Sketch
San Luis Obispo harbor	Hydrographic survey	do
San Simeon harbor	do	do
Monterey harbor	Complete survey	Preliminary chart
Sauquel cove	do	
Santa Cruz harbor	do	Sketch
Point Año Nuevo harbor	Topographical and hydrographic survey	do
San Francisco harbor	Complete survey	Preliminary chart
Mendocino City harbor	Hydrographic survey	Sketch
Shelter cove	do	do
Crescent City harbor	do	do
Port Orford, or Ewing harbor	Topographical and hydrographic survey	do
Grenville harbor	Hydrographic survey	do
Nee-ah harbor	Topographical and hydrographic survey	do
False Dungeness	Hydrographic survey	do
New Dungeness	Complete survey	do
Port Townshend	do	do
Port Ludlow	do	do
Mats-Mats, or Boat harbor	do	do
Port Gamble	do	do
Apple cove	Topographical survey	
Murden's cove	do	
Blakeley harbor	Hydrographic survey	Sketch
Steilacoom harbor	do	do
Olympia harbor	do	do
BAYS.		
San Diego bay	Complete survey	Preliminary chart
False bay	Topographical survey	
Monterey bay	Complete survey	Preliminary chart
San Francisco bay	do	
San Pablo bay	do	Finished map
Ballenas bay	do	
Sir Francis Drake's bay	Preliminary survey	Sketch
Tomales bay	Topographical survey	
Humboldt bay	Topographical and hydrographic survey	Sketch
Trinidad bay	Hydrographic survey	do
Shoalwater bay	do	do
Duwamish bay	do	do
Strawberry bay	Topographical survey	
Bellingham bay	Hydrographic survey	Sketch
Semiahmoo bay	do	
REEFS AND BANKS OR SHOALS.		
Cortez bank	Hydrographic survey	Chart
Duxbury reef	Complete survey	On map of San Francisco entrance.

APPENDIX No. 7—Continued.

Names in geographical order.	Character of survey.	Published.
STRAITS AND ENTRANCES.		
San Diego entrance	Complete survey	Preliminary chart
Santa Barbara channel, eastern entrance of	Hydrographic survey	do
San Francisco entrance	Complete survey	Finished map
Carquines straits	do	On map of San Pablo bay
Mare Island straits	do	Finished map
Umpquah river entrance	Hydrographic survey	Sketch
Columbia river entrance	Complete survey	Preliminary chart
Admiralty inlet	Topographical survey	Sketch
Entrance to Hood's canal	do	
Entrance to Port Gamble	do	
Canal de Haro and Strait of Rosario	Reconnaissance	Sketch
RIVERS.		
Santa Clara river	Topographical survey	
Salinas river	do	
Pajaro river	do	
San Antonio creek	Complete survey	Finished map
Petaluma creek	do	On map of San Pablo bay
CITIES AND TOWNS.		
San Diego	Complete survey	On sketch of San Diego bay
Santa Barbara	do	On sketch of Santa Barbara
City of Monterey	do	On sketch of Monterey bay
City of San Francisco	do	Map
Oakland City	do	On map of San Antonio creek.
Brooklyntown	do	
Vallejo	do	On map of San Pablo bay
Benicia	do	do
Humboldt	do	On sketch of Humboldt bay.
Bucksport	do	do
Eureka	do	do
Trinidad	do	On sketch of Trinidad bay
Steilacoom	do	On sketch of Steilacoom harbor.
Olympia	do	On sketch of Olympia harbor.

APPENDIX No. 8.

Statistics of field and office-work of the United States Coast Survey during the years—

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	Total.
Reconnaissance—																
Area, in square miles	9,642	1,140	3,739	1,830	2,950	3,940	10,159	3,280	3,510	1,706	1,708	795	1,487	4,072	2,855	52,813
Parties, number of, in each year	4	2	4	5	5	7	6	4	6	6	5	13	7	5	8	....
Base lines—																
Primary, number of	1	2	....	....	1	1	....	1	....	....	1	....	2	....	1	10
Secondary, number of	2	....	....	....	2	1	4	3	3	4	5	2	8	8	1	43
Length of, in miles	19⅜	16	....	....	9¼	13	6¼	17¼	2	4⅜	18⅜	3¾	24⅜	9½	9	153¼
Triangulation—																
Area, in square miles	9,076	795	2,166	1,185	1,903	2,592	4,091	2,097	2,465	1,703	3,089	2,701	2,729	2,793	1,640	41,025
Extent of general coast, in miles	570	179	162	123	159	115	985	216	243	220	94	246	188	320	357	3,477
Extent of shore line, in miles, including bays, sounds, islands and rivers	1,588	589	554	1,018	541	796	1,328	730	1,097	1,104	759	1,269	1,401	1,895	1,481	16,150
Horizontal angle stations occupied	750	120	89	197	120	98	204	157	184	223	224	204	410	544	385	3,900
Geographical positions determined	1,183	147	148	372	194	227	319	294	307	446	346	388	584	1,240	777	6,972
Vertical angle stations occupied	15	2	5	7	3	1	18	13	22	14	7	89	6	1	4	207
Elevations determined, number of	44	12	7	46	44	1	59	22	58	66	9	127	6	12	15	523
Parties, number of, in each year	4	5	8	7	8	10	13	14	14	13	18	17	17	20	20	....
Astronomical operations—																
Stations occupied for azimuth	9	8	2	2	3	3	4	4	6	6	9	5	4	2	1	68
Stations occupied for latitude	9	8	5	3	8	2	4	6	8	17	20	6	4	6	3	109
Stations occupied for longitude	1	1	....	2	3	3	7	3	7	18	21	4	1	1	2	74
Permanent longitude stations	....	1	1	2	1	1	2	3	5	5	5	4	3	1	1	....
Parties, number of, in each year	1	3	2	2	3	3	5	5	6	4	7	7	6	4	3	....
Magnetic stations occupied, number of	....	14	21	28	19	4	11	9	10	8	13	9	8	23	6	183
Parties, number of, in each year	....	2	3	3	3	3	5	4	3	2	3	6	3	4	3	....
Topography—																
Area surveyed, square miles	6,102	239	504	842	570	506	574	558	705	696	460	517	537	559	1,085	14,454
Length of general coast, in miles	414	110	168	119	117	185	95	133	260	236	251	174	178	165	309	2,912
Length of shore line, in miles, including rivers, creeks and ponds	7,667	424	908	1,528	1,567	1,378	1,901	1,441	2,297	1,826	1,730	1,713	1,600	2,505	4,385	32,870
Length of roads, in miles	12,239	610	1,169	1,590	1,156	712	458	430	750	579	532	604	510	786	1,508	23,633
Parties, number of, in each year	6	5	6	8	9	9	11	11	13	13	17	12	17	17	23	....
Hydrography—																
Parties, number of, in each year	2	5	5	6	6	8	11	11	12	9	9	10	11	12	12	....
Soundings, number of	808,147	120,827	125,173	220,402	228,402	255,003	265,824	264,718	371,660	288,375	305,377	162,454	526,875	439,614	506,034	4,888,885
Soundings in Gulf Stream for temperature	....	....	118	581	207	425	....	....	....	....	1,053	257	310	....	478	3,429
Tidal stations, permanent	20	8	11	12	20	14	16	15	24	29	34	24	19	25	24	295
Tidal stations occupied temporarily	107	8	24	29	16	18	22	29	31	51	51	72	68	39	34	599
Tidal parties, number of, in each year	2	5	5	5	5	8	11	11	12	9	11	12	13	14	14	....
Current stations occupied	....	27	42	41	59	54	28	44	41	24	89	10	84	84	156	783

APPENDIX No. 8—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	Total.
Hydrography—																
Current parties, number of, in each year	....	3	5	3	3	4	6	4	7	7	5	3	5	6	6	....
Specimens of bottom, number of	1,029	2,775	89	159	279	769	287	331	278	217	191	79	173	161	184	7,001
Records—																
Triangulation, originals, number of vols	97	12	17	23	17	32	38	40	33	33	64	46	79	96	76	703
Astronomical observations, originals, number of volumes	17	10	11	10	16	22	72	30	41	48	29	88	35	12	35	476
Magnetic observations, originals, number of volumes	4	2	1	6	7	4	3	5	5	7	6	4	33	13	4	104
Duplicates of the above, number of vols	27	26	32	32	44	49	19	23	45	73	76	84	139	101	140	910
Computations, number of volumes	78	25	17	21	26	23	57	24	40	72	101	91	109	99	83	866
Hydrographic soundings and angles, originals, volumes	188	22	26	152	54	154	134	170	213	206	183	66	332	197	319	2,416
Hydrographic soundings and angles, duplicates, volumes	28	2	5	4	11	11	12	12	16	27	15	7	26	27	21	224
Tidal and current observations, originals, volumes	127	23	47	51	44	40	67	88	114	139	123	70	196	110	213	1,452
Tidal and current observations, duplicates, volumes	... .	23	47	51	44	41	63	79	385	132	114	79	87	100	67	1,312
Sheets from self-registering tide-gauges, number of	....	....	....	....	....	....	....	....	....	26	72	106	80	103	119	506
Tidal reductions, number of volumes	....	46	94	102	88	80	16	58	22	26	17	99	79	73	63	863
Total number of volumes of records	566	191	297	452	351	456	395	424	914	763	717	616	1,096	807	1,006	9,051
Maps and charts—																
Topographical maps, originals	168	14	16	25	25	19	19	29	36	31	34	47	77	45	90	675
Hydrographic charts, originals	142	9	8	21	21	16	16	24	42	25	49	57	60	58	51	599
Reductions from original sheets, number of	15	9	15	16	17	13	18	22	26	48	35	27	36	39	40	376
Total number of manuscript maps and charts	325	32	39	62	63	48	53	75	104	104	118	131	173	142	181	1,650
Number of sketches made in field and office	311	24	33	32	29	48	82	85	126	137	103	101	132	125	132	1,500
Engraving and printing—																
Engraved plates of finished charts, number of	5	2	3	5	3	6	3	5	6	5	4	2	7	3	7	66
Engraved plates of preliminary charts, sketches, and diagrams for Coast Survey reports, number of	....	....	....	4	5	7	6	10	38	20	39	42	46	51	51	319
Electrotype plates made in each year	....	....	....	....	1	7	6	25	16	23	47	77	50	69	79	400
Finished charts published in each year	....	4	3	4	3	10	3	4	6	6	3	2	8	3	5	64
Preliminary charts and hydrographic sketches published	....	....	....	2	4	2	4	10	36	19	34	34	34	38	41	258

APPENDIX No. 8—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	Total.
Engraving and printing—																
Printed sheets of maps and charts distributed	....	169	416	1,708	1,104	2,923	1,848	326	5,649	5,799	8,042	5,195	5,392	8,858	19,147	66,576
Printed sheets of ditto deposited with sale agents	....	....	883	1,686	4,981	5,016	1,506	3,115	5,168	6,866	4,375	3,232	2,577	2,898	648	42,948
Library—																
Number of volumes	....	....	....	....	....	655	95	590	333	171	273	155	250	389	106	3,017
Instruments—																
Cost of	....	....	....	....	....	....	$8,326	$4,652	$4,603	$3,835	$5,296	$5,402	$3,958	$5,369	$3,185	....

GENERAL NOTE.

Parties.—An average number is given for the years previous to 1844. A party operating in more than one section during the year is counted but once.

Triangulation.—The extent of general coast is measured in general outline, including Delaware and Chesapeake, as well as all open bays; but omitting the minor indentations of the seacoast. The extent of shore-line is also measured in general outline, and includes such rivers only as have been triangulated.

Topography.—The length of the general coast is measured similarly to that under triangulation; but the shore-line under topography represents the whole water-line surveyed, including all the minor indentations.

Records.—The total number of volumes of records given in the table is greater than the number now on hand, owing to the binding up of separate volumes.

Engraved Plates.—Progress sketches (averaging fourteen yearly) are not counted.

Library.—The number of volumes purchased and donated up to 1849 was 655.

APPENDIX No. 9.

General list of Coast Survey discoveries and developments to 1857, *inclusive.*

1. Temple's ledge, near Cape Small Point, Maine, 1857.

2. Determination of the position of a sunken rock, on which the steamer Daniel Webster struck, in Casco bay, on the evening of the 13th of October, 1856.

3. Determination of the dimensions of Alden's rock, near Cape Elizabeth, Maine, 1854.

4. Determination of rocks off Marblehead and Nahant, 1855.

5. A rock (not on any chart) in the inner harbor of Gloucester, Massachusetts; discovered in 1853.

6. A bank, ninety miles eastward of Boston, with about thirty-six fathoms of water, probably a knoll connected with Cashe's ledge, but with deep water between it and the ledge, 1853.

7. Boston harbor; Broad Sound channel thoroughly surveyed, and marks recommended, 1848.

8. Several rocks in the fair channel way in Boston harbor entrance, 1854.

9. A bank (Stellwagen's Bank) with ten and a half to fourteen and a half fathoms of water on it, at the entrance to Massachusetts bay, and serving as an important mark for approaching Boston and other harbors, 1854.

10. Extension of Stellwagen's Bank to the southward and eastward some sixteen or seventeen square miles, enclosed by the twenty-fathom curve, 1855.

11. Changes in the vicinity of East Harbor, (Cape Cod,) 1857.

12. A dangerous sunken ledge (Davis' ledge) to the eastward and in the neighborhood of Minot's ledge, 1854.

13. Development of a reef extending between Minot's and Scituate light, 1856.

14. A sunken rock, with only six feet on it at low water, off Webster's Flag Staff, Massachusett's bay, 1856.

15. A dangerous rock, near Saquish Head, entrance to Plymouth harbor, 1856.

16. Three rocks determined in position, partly bare at low water, off Manomet Point, Massachusett's bay, 1856.

17. Determination of a very dangerous rock off Indian Hill, and four miles southward of Manomet Point, Massachusetts bay, with as little as six feet water on it, 1856.

18. Probable connection of George's Bank and the deep-sea banks north and east of Nantucket, 1855.

19. The decrease of depth, with general permanence of form of George's Bank, off the coast of Massachusetts, 1857.

20. A shoal spot near Little George's Bank, 1857.

21. Non-existence determined of "Clarke's Bank" and "Crab ledge," laid down on certain charts as distinct from an immense shoal ground off Cape Cod peninsula, 1856.

22. Nantucket shoals; Davis' New South shoals, six miles south of the old Nantucket South shoals, in the track of all vessels going between New York and Europe, or running along the coast from the eastern to the southern States, or to South America; discovered in 1846.

23. Two new shoals, north and east of Nantucket; discovered in 1847.

24. Six new shoals near Nantucket; the outermost fourteen and a half miles from land, and with only ten feet water; discovered in 1848.

25. McBlair's shoals, off Nantucket; discovered in 1849.

26. The tidal currents of Nantucket shoals and the approaches, 1854.

27. Davis' Bank, Nantucket shoals; discovered in 1848, and survey finished in 1851.

28. Fishing Rip, a large shoal extending north and south, about ten miles to the eastward of Davis' Bank, and thirty miles from Nantucket, with four and a half fathoms; surveyed in 1852.

29. A ridge connecting Davis' New South shoal and Davis' Bank; found in 1853.

30. A small bank or knoll, with but five fathoms on it, about five miles east of Great Rip, with twelve fathoms between it and Davis' Bank and Fishing Rip, the water gradually deepening outside of it to the northward and eastward, beyond the limits of the series of shoals.

31. Discovery of Edwards' shoal, one mile and seven-eighths southward of Nantucket light-boat, 1855.

32. Examination of the interference tides of Nantucket and Martha's Vineyard sounds, 1855.

33. The study of the tidal currents of the Vineyard and Nantucket sounds, 1857.

34. Contraction of the inlet at the north end of Monomoy island, and opening of new entrance to Chatham harbor, 1853.

35. Muskeget channel; surveyed by Lieutenant C. H. Davis in 1848, and Lieutenant C. H. McBlair in 1850.

36. Discovery of two shoal spots, with twelve and thirteen feet water, eastward from Great and Little Round shoals, Nantucket sound, 1856.

37. Determination of two shoal spots near the northern extremity of Davis' Bank, with fourteen and eighteen feet water, 1856.

38. Further development of Edwards' shoal, three-fourths of a mile from the Southern Cross Rip, Nantucket sound, 1856.

39. Shoal sand ridges discovered northward of Great Point light, Nantucket sound, 1856.

40. Important changes in geographical feature at the southeastern end of Martha's Vineyard, Muskeget channel, 1856.

41. Numerous rocks in Martha's Vineyard sound, Long Island sound, and the various bays and harbors connected with them.

42. The tidal currents of Long Island sound, 1854.

43. The tidal currents of Hell Gate, 1857.

44. Least water on the Hell Gate rocks, determined by dragging, 1857.

45. The currents of the great bay between Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, 1855.

46. Gedney's channel into New York bay, having two feet more water than the old channels. Had the true depth of this channel been known in 1778, (then probably existing, as seen by comparing old and new charts,) the French fleet under Count D'Estaing would have passed into the bay and taken the assembled British vessels.

47. The changes in New York harbor, near New York city, between 1845 and 1858.

48. Increase of depth in Buttermilk channel, ascertained and made known, in 1848, by survey of Lieutenant D. D. Porter, United States navy.

49. Shoal in the main ship channel of New York harbor, 1855.

50. The tides of Hudson river, 1856.

51. Sandy Hook. Its remarkable increase traced from the surveys of the topographical engineers and others, and by several successive special surveys, made between 1844 and 1857.

52. Delaware bay; Blake's channel, at the entrance, discovered in 1844; open when the eastern channel is closed by ice. This discovery has served to develop strikingly the resources of that portion of Delaware.

53. Blunt's channel, in Delaware bay.

54. Changes in the Delaware, near the Pea Patch.

55. The true extent and position of the dangerous shoals near Chincoteague inlet, Virginia, 1852.

56. Metomkin inlet, Virginia, shoaling from eleven to eight feet in the channel during 1852.

57. Two channels into Wachapreague inlet, Virginia; one from the northward, and the other from the eastward, both with seven feet water at low tide, 1852.

58. A shoal half a mile in extent, not put down on any chart, $5\frac{1}{2}$ miles east from the north end of Paramore's island, Virginia; it has but four fathoms water on it and nine fathoms around it, 1852.

59. Great Machipongo inlet, Virginia; found to have a fine, wide channel, with eleven feet water on the bar at low ebb, and fourteen at high tide; good anchorage inside, in from two to eight fathoms; the best harbor between the Chesapeake and Delaware entrances, 1852.

60. Two shoals near the entrance to the Chesapeake, one $4\frac{3}{4}$ nautical miles SE. by E. from Smith's Island light-house, with seventeen feet water upon it; the other E. by S. nearly $7\frac{3}{4}$ miles from the same light, with nineteen and a half feet upon it, 1853.

61. Only three feet water upon the "Inner Middle," the shoal part of the Middle Ground, west of the "north channel," at the Chesapeake entrance, 1852.

62. A twenty-five fathom hole $2\frac{1}{2}$ miles W.SW. from Tazewell triangulation point, eastern shore of the Chesapeake; all other charts give not more than sixteen fathoms in this vicinity.

63. A shoal at the mouth of the Great and Little Choptank, in Chesapeake bay, 1848.

64. The sounding and measurement of the bars in Rappahannock river, 1855.

65. The general permanence of the Bodkin channel, and shoals in its vicinity, at the entrance of the Patapsco river, between 1844 and 1854.

66. A shoal (New Point shoal) in Chesapeake bay, with sixteen feet water on it, southeast from New Point Comfort light-house, off Mobjack bay, 1854.

67. Re-examination of York Spit, Chesapeake bay, and least water determined, (nine feet,) 1855.

68. York river, Virginia, as a harbor, 1857.

69. A reconnaissance of the Wimble shoals, near Nag's Head, coast of North Carolina, 1854.

70. Sub-marine range of hills beyond the Gulf Stream, tracked from Cape Florida to Cape Lookout, 1855.

71. Deep water found on Diamond shoal, and a dangerous nine feet shoal off Cape Hatteras, 1850.

72. A new channel, with fourteen feet water, into Hatteras inlet, formed during the year 1852, which is better and straighter than the old channel.

73. Changes at Hatteras and Ocracoke inlets, 1857.

74. The general permanence in depth on the bar of Beaufort, North Carolina, with the change of position of the channel, 1854.

75. Changes on the bar of Beaufort, North Carolina, 1857.

76. The well ascertained influence of prevailing winds in the movement of the bars at Cape Fear and New Inlet entrances, and the gradual shoaling of the main bar; the latter fact being of great importance to the extensive commerce seeking that harbor, 1853.

77. Changes in the main Western and New Inlet channels in Cape Fear, 1855.

78. Frying Pan shoals, off Cape Fear, North Carolina; a channel of $2\frac{1}{2}$ fathoms upwards of a mile wide, distant eleven nautical miles from Bald Head light-house, across the Frying Pan shoals. A channel extending from three to four miles from the point of Cape Fear to 8 or $8\frac{1}{2}$ miles from it, with sufficient water at low tide to allow vessels drawing from nine to ten feet to cross safely. A channel at the distance of fourteen nautical miles from Bald Head light-house, one mile wide, with $3\frac{1}{2}$ to 7 fathoms water on it. The Frying Pan shoals extend twenty nautical miles from Bald Head light-house, and 16, 17, and 18 feet water, is found 17 and 18 nautical miles out from the light, 1851.

79. Shoaling of Cape Fear river bar thoroughly examined for purposes of improvement, 1852.

80. Changes of the Cape Fear bars and channels, 1857.

81. Changes at the entrance of Winyah bay and Georgetown harbor, and the washing away of Light-House Point at the same entrance, 1853.

82. Maffitt's new channel, Charleston harbor, with the same depth of water as the ship channel, 1850.

83. The changes in Maffitt's channel, Charleston harbor, South Carolina, from 1852 to 1857.

84. Changes in the main ship channel, Charleston harbor, 1855.

85. Changes in the channels at the entrance of Charleston harbor, 1852.

86. The remarkable discovery of continuous deep-sea soundings off Charleston, and of soundings in the depth of between four and five hundred fathoms beyond the Gulf Stream, 1853.

87. Development of the changes affecting the entrance to North Edisto river, South Carolina, 1856.

88. Discovery of a new channel between Martin's Industry (shoal) and the southeast breakers, Port Royal entrance, South Carolina, 1856.

89. Discovery of cold water at the bottom of the ocean below the Gulf Stream, along the coasts of North and South Carolina, Georgia, and Florida, 1853.

90. The discovery of the cold wall, alternate warm and cold bands, and various other features of the Gulf Stream, especially such as concern its surface and deep-sea temperatures, and its distribution relative to the shore and bottom of the ocean.

91. Various facts relative to the distribution of minute shells on the ocean bottom, of probable use to navigators for recognizing their positions.

92. Examination of Doboy, St. Simon's, and Cumberland entrances, 1855.

93. A shoal inside of the entrance to Amelia river, Florida, 1857.

94. Hetzel shoal, off Cape Cañaveral, Florida, 1850.

95. Temperature of 34° beneath the Gulf Stream, thirty-five miles east of Cape Florida, at a depth of three hundred and seventy fathoms, 1855.

96. A harbor of refuge (Turtle harbor) to the northward and westward of Carysfort light-house, Florida reef, with a depth of water of twenty-six feet at the entrance, 1854.

97. A new passage, with three fathoms water, across the Florida reef, to Legaré harbor, under Triumph reef, (latitude 25° 30′ N., longitude 80° 03′ W.,) which, if properly buoyed, will be valuable as a harbor of refuge.

98. A safe rule for crossing the Florida reef near Indian key, 1854.

99. A new channel into Key West harbor, 1850.

100. Co-tidal lines for the Atlantic coast of the United States, 1854.

101. Rules for navigators in regard to the tidal currents of the coast, 1857.

102. Isaac shoal, near Rebecca shoal, Florida reef, not laid down on any chart, 1852.

103. Channel No. 4, a northwest entrance into Cedar Key's bay, 1852.

104. Directions for entering the harbor from Crystal river offing, western coast of Florida peninsula, 1856.

105. Mobile bay entrance bar; in 1832 only seventeen feet at low water could be carried over it; in 1841 it had nineteen; and in 1847 it had twenty feet and three-quarters, as shown by successive surveys, 1847.

106. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay, 1853.

107. Horn Island channel, Mississippi sound.

108. The removal of the east spit of Petit Bois island, in the hurricane of 1852, opening a new communication between the Gulf and Mississippi sound, and the rendering of Horn Island Pass more easy of access by the removal of knolls, 1853.

109. The accurate determination of Ship shoal, off the coast of Louisiana, in connection with the site for a light-house, 1853.

110. An increase of depth of water on the bar of Pass Fourchon, Louisiana, 1854.

111. Deep-sea soundings in the Gulf of Mexico, 1855–'56.

112. Tidal phenomena of the Gulf, 1855.

113. The changes at Aransas Pass, Texas, as bearing on the question of a light-house site, 1853.

114. Co-tidal lines of the Gulf of Mexico, 1856.

115. On the effect of wind in disturbing the tides of the Gulf of Mexico, 1856.

116. Development of a bar at the entrance of San Diego bay, California, 1856.

117. A shoal inside of Ballast Point, San Diego bay, with only twelve and a half feet of water, not laid down on any chart, 1852.

118. The determination of the position and soundings on Cortez bank, off the coast of California, 1853.

119. Complete hydrographic survey and determination of a point of rock on Cortez shoal, 1856.

120. Tides of San Diego, San Francisco, and Astoria, 1854.

121. The non-existence of San Juan island, usually laid among the Santa Barbara group, 1852.

122. Co-tidal lines of the Pacific coast, 1855.

123. Determination of Uncle Sam Rock, 1855.

124. Investigation of the currents of Santa Barbara channel, 1856.

125. Red sand marking the inner entrance to the Golden Gate, 1855.

126. Channel sounded out between Yerba Buena and the Contra Costa, San Francisco bay, 1855.

127. Further development of the extent of Commission Rock, San Pablo bay, 1856.

128. Changes in the channel entrance of Humboldt bay or harbor, California, 1852 and 1853.

129. South channel, Columbia river, surveyed and made available to commerce, 1851.

Changes of channels, their southward tendency, and a new three-fathom channel from Cape Disappointment, due west, to open water, Columbia entrance, 1852; further changes, 1853.

130. The depth of water on the bars at the entrance of Rogue river and Umpquah river, Oregon, 1853.

131. A shoal at the northern entrance to the strait of Rosario, Washington Territory, giving good holding ground in thirty-three feet, 1854.

132. Boulder reef, northwest of Sinclair island, Rosario strait, partly bare at unusually low tides, and surrounded by kelp, 1854.

133. Belle Rock, in the middle of Rosario strait, visible only at extreme low tides, 1854.

134. Entrance Rock, at the entrance of Rosario strait, 1854.

135. Unit Rock, in the Canal de Haro, Washington Territory, visible only at extreme low tides, 1854.

136. A three-fathom shoal in the strait of Juan de Fuca, off the southeast part of Bellevue or San Juan island, 1854.

137. Allen's Bank, Admiralty inlet, Washington Territory, 1857.

138. A five-fathom shoal in the strait of Juan de Fuca, between Canal de Haro and Rosario strait, 1854.

139. A bank in eleven fathoms, off the southern entrance to Canal de Haro, 1854.

140. The non-existence of two islands at the northern entrance of Canal de Haro, laid down on charts, 1853.

141. Various surveys and charts of small harbors on the Pacific coast of the United States, and a continuous reconnaissance of the entire Western Coast and islands adjacent, a great part of which was imperfectly known.

142. Winds of the Western Coast of the United States, 1857.

Additional List for 1858.

1. Fishing ledge, off Kennebunk, Me., thoroughly sounded.

2. A rock one mile to the southward and westward of Boon island, with seventeen feet water. The sea breaks on it in heavy weather.

3. Development of Boon Island ledge, coast of Maine.

4. A rock off Cape Neddick, Me., determined in position.

5. A detached rock two-thirds of a mile northward and eastward of York ledge, Me.

6. Determination of the position of a rock more than a mile off the mouth of York river, Me., bare at low tides, and dangerous to coasters.

7. Development of Duck Island ledge.

8. A very dangerous rock with only six and a half feet water off the entrance to Portsmouth harbor, N. H., about four nautical miles eastward from the Whale's Back light.

9. A rock with twelve feet at mean low water about four miles and a third eastward of the Whale's Back.

10. An extension of the sand spit to the southward of Sunken ledge, Boston harbor, since the survey of 1847.

11. Luddington Rocks, determined in position, about ten yards apart, a mile and a half (nautical) southwest, by compass, from New Haven light-house.

12. Tidal currents in East river, N. Y., and surface and sub-currents investigated in New York harbor, the lower bay, and on the bar.

13. Changes of shore-line and hydrography determined at the Cape Fear entrances, N. C.

14. Increase of depth developed in Maffitt's channel, Charleston harbor, S. C.

15. A new channel discovered, leading into St. George's sound, (Apalachicola, Fla.,) at the east end of Dog island, and anchorage connected with it.

16. Shoals near the East and West Passes of St. George's sound, (Apalachicola, Fla.,) and a new channel found between St. George's and St. Vincent's islands.

17. Whiting's Rock, determined in position, near the "Brother's," at the entrance of San Pablo bay, Cal.

18. A reef developed off the Contra Costa flats, San Francisco bay, Cal.

19. A bank of three and a half fathoms, about a mile off the southwest point of Sucia island, at the northern entrance of Washington Sound, W. T.

APPENDIX No. 10.

Letter to the Secretary of the Treasury, communicating data for the position, and directions for clearing a dangerous rock off the entrance to Portsmouth, N. H., developed by the examination of Lieut. Comg. Alexander Murray, U. S. N., Assistant in the Coast Survey.

COAST SURVEY STATION,
Beddington, Me., September 10, 1858.

SIR: I have the honor to report the finding of a dangerous rock off the entrance to the harbor of Portsmouth, N. H., with as little as six and a half feet of water on it at mean low tide. The rock is a part of Triangle ledge, and was found on the 9th of August by Lieut. Comg. Alexander Murray, U. S. N., Assistant in the Coast Survey, in the surveying steamer Bibb, that vessel striking with violence on it, as its position was not laid down on any known chart of the locality.

Lieut. Comg. Murray has furnished the following data for the geographical position of this danger to the navigation of the vicinity of the entrance to Portsmouth:

"The monument on York ledge bears N. 29° 15′ E.; distance, $1\frac{3}{4}$ nautical mile.

"The light on Whale's Back bears S. 78° west; distance, 4 nautical miles.

"Boon island is $6\frac{1}{2}$ nautical miles distant, and, with Whale's Back on range, will nearly include the rock, it being 6° 30′ to the southward."

The report of Lieut. Comg. Murray contains also the following direction for clearing the rock:

"After doubling the bell-buoy off Boon island, vessels should keep the Whale's Back open to the northward at least two points until they pass the monument on York ledge.

"The rock has six and a half feet water at mean low tide, and within a ship's length seven and eleven fathoms. It should be buoyed."

I would respectfully request the transmission of a copy of this communication to the Light-house Board, and authority to publish it from the Coast Survey Office in the usual form, as a notice to mariners.

Very respectfully, yours,

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 11.

Letter to the Secretary of the Treasury, transmitting the recommendation of Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast Survey, for a buoy on the sand spit recently formed at the southern end of Sunken ledge, Boston harbor.

CHESHIRE, CONN., *October* 18, 1858.

SIR: I have the honor to transmit, for the information of the Light-house Board, an extract from a report recently made by Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast Survey, after an incidental examination of the vicinity of Sunken ledge, in Boston harbor.

My attention having been called by Capt. R. B. Forbes, of Boston, to the fact that a spit of sand or gravel had made off from the actual ledge to the southward since the period of the survey, Lieut. Comg. Temple determined the length of that formation, and in reference to it he remarks: "The shoal spit which makes off to the southward of Sunken ledge extends further than is represented on the published Coast Survey chart of Boston harbor, and requires a buoy to mark its extremity, which lies four hundred and fifty yards south from the beacon."

I would respectfully request that a copy of this communication may be furnished to the Light-house Board.

Very respectfully, yours,

A. D. BACHE,
Superintendent United States Coast Survey.

HON. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 12.

Letter to the Secretary of the Treasury, communicating the position of two points of rock southwest of the light-house near New Haven, Conn., as determined by Lieut. Comg. W. G. Temple, U. S. N., Assistant in the Coast Survey.

COAST SURVEY STATION NEAR BANGOR, ME.,
September 13, 1858.

SIR: I have the honor to communicate, for the benefit of navigation and for the information of the Light-house Board, the following extracts from a report by Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast Survey, in charge of the steamer "Corwin," on an examination for a rock reported to exist in the vicinity of New Haven, Conn.:

"Agreeably to your instructions of June 19 and 25, I stopped at New Haven to search for a rock reported by the pilots as not laid down upon the published chart, and I have now to submit the following report:

"At a distance of exactly one and a half ($1\frac{1}{2}$) nautical mile due SW., by compass, from the light-house there are two sharp pointed rocks, lying some ten (10) yards apart, and having but twelve and a half ($12\frac{1}{2}$) feet of water on them at low tide, or when reduced to the plane of reference of the published chart. All around them is to be found from seventeen (17) to nineteen and a half ($19\frac{1}{2}$) feet.

"I would recommend that a striped buoy be placed on the spot, which can be accurately pointed out by the pilots by means of cross-ranges, which I selected and showed them.

"I would also recommend that a black buoy be placed on the eleven (11) feet shoal, which lies about three-quarters ($\frac{3}{4}$) of a mile to the northward of these rocks.

"Both of these buoys are much needed for safe navigation."

I propose to call these rocks "Luddington Rocks," after the pilot who called attention to them, and would respectfully request authority to publish this in the usual form, as a notice to mariners, and that a copy of it may be transmitted to the Light-house Board.

I am indebted to G. W. Blunt, esq., for the information which led to this examination.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 13.

Report of Lieut. Comg. T. B. Huger, U. S. N., Assistant in the Coast Survey, showing the result of comparisons of the hydrographic surveys made in December, 1856, *and March*, 1858, *at the entrances of Cape Fear river, N. C.*

UNITED STATES SCHOONER CRAWFORD,
Smithville, N. C., June 17, 1858.

SIR: I herewith forward charts of my resurvey of the north and south entrances to Cape Fear river, made in obedience to your order, which was received at Fernandina in April last, for the "Cape Fear commission," and note the following changes as the result of comparison between them and corresponding sheets executed by Lieut. Comg. J. N. Maffitt in 1856:

Bald Head and Western bar.—The 18 and 12 feet curves remain nearly the same, there being no material change in either, except the existence now of two spots, one of 15 feet, about 150 yards to the southward of Bald Head wharf, and one of 16 feet, about the same distance to the northward, which is not shown on the chart of 1857. The shore-line to the northward of the wharf seems to have washed in about 20 yards. Little or no change has taken place to the eastward of the wharf. The pocket has undergone but a slight change, though it is apparently cutting away towards the outer buoy on the western bar. The Middle Ground has remained about the same—in many places on the shoal where I have run lines in this work there are none on the chart of 1857, so that I have been unable to make a reference. The rip has undergone but slight alterations, and this is so continually shifting that it would be almost impossible to make any comparison that would be lasting enough for service in future. I found two 6 feet spots which seemed unknown to the pilots; it has now a depth of 7 feet at mean low water.

New Inlet.—The changes of shore-line on Zeek's island are considerable. There are now two openings, made by the gale of 1857, through which the tide runs with great force. In one of them there is a depth, in spots, of 20 feet. Around the wharf the sand is making very rapidly, so much so, in fact, during the month I had the tide-gauge there, as to compel me to alter its location, or more properly to extend it some ten or twelve feet out from its first position, close by the outer piles of the wharf. Federal Point, opposite Zeek's Island wharf, has changed but little, but the bulkhead which threatened to close the entrance has become broken and detached, particularly towards the northern end. The SW. spit of Zeek's island has been washed away some twenty yards, while a little further to the eastward it has made out some fifty yards, and to the northward it has again washed away some forty yards. New Inlet bar seems to have undergone but slight changes since the survey of 1856, by Lieut. Comg. Maffitt.

I am, very respectfully, your obedient servant,

T. B. HUGER,
Lieut. Comg. U. S. N., Assistant Coast Survey.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 14.

Report of Assistant C. P. Bolles on the results of a topographical resurvey of the shores of the Cape Fear entrances and adjacent islands.

Smithville, N. C., *August* 22, 1858.

Sir: The topographical resurvey of the shores of the harbor of Cape Fear river, and the approaches to the same, was commenced on the 8th of April, and completed on the 31st of May.

The following comparisons derived from the resurvey may be found useful, and are therefore respectfully submitted:

1st. The sea-shore of Oak island from abreast of the range lights to "Oak" station, two miles west of Fort Caswell, has washed away from fifteen to twenty metres. "Oak," which was one of the points in the chain of triangulation, extended to the westward and located on a sand-hill some twelve feet high, is now below high water mark, and therefore lost.

2d. The shore on the north side of Bald Head Point is making out as far as the bight, (half-way between the point and the light-house;) from this bight to Cape Creek the shore is washing away.

3d. The south shore of Smith's island is washing away, and the Cape has turned more to the westward.

4th. The whole of the eastern shore of Smith's island has washed away at least twenty metres, and North and South Base are destroyed by the encroachments of the sea.

5th. Zeek's island is washing away on the east side, and making gradually on the north and west sides.

6th. Federal Point is moving gradually towards the southwest.

7th. The eastern shore of Snow's marsh (lying opposite to New Inlet) is washing away gradually.

8th. The western shore of the river between McRacken's signal and Deep Water Point is washing away, and marsh is now forming there.

9th. The shoal on the west and south side of Battery island remains about the same.

Very respectfully, yours,

CHARLES P. BOLLES,
Assistant Coast Survey.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey.

APPENDIX No. 15.

Letter to the Secretary of the Treasury, communicating the results of a resurvey of Maffitt's channel, made in March, 1858, by Lieut. Comg. T. B. Huger, U. S. N., Assistant in the Coast Survey.

COAST SURVEY OFFICE, *May* 11, 1858.

SIR: I have the honor to state that, as part of the hydrographic operations of the season in Section V, a resurvey of Maffitt's channel leading into Charleston harbor, S. C., was made in March by Lieut. Comg. T. B. Huger, U. S. N., Assistant in the Coast Survey, with a view to ascertain the changes effected by dredging and natural causes.

The following extracts from a report addressed to me by that officer show the results of the recent examination:

"From a comparison of my soundings with those made by Lieut. Comg. Maffitt in 1857, I find changes of a character calculated to encourage the belief that this channel will soon become the main passageway for the commerce of Charleston."

"In June, 1857, the outer and inner twelve feet curves were separated by the bulkhead twenty-four hundred feet. The recent survey shows that the channel has deepened, and that the distance between the twelve feet curves is now only seven hundred and ninety feet."

"The water on the shoal spit of the bulkhead has materially deepened, and the play of the current upon that locality seems to be acting favorably for the channel."

"Maffitt's channel has eighteen inches more water at present than it had in June, 1857, and the general character of the channel in width and depth has decidedly improved."

The tendency to improvement in the capacity of this entrance to Charleston harbor being of general interest to navigation on the Atlantic Coast, I would respectfully request authority to publish the results here set forth in the usual form of notice to mariners.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 16.

Letter to the Secretary of the Treasury, communicating the discovery and sounding out of a new channel leading into the eastern end of St. George's sound, Florida, by Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey.

COAST SURVEY OFFICE, *May* 18, 1858.

SIR: I have the honor to communicate the discovery of a new channel leading into St. George's sound, Florida, the sound of which Apalachicola bay is an arm, by the Coast Survey parties working there.

The channel has been sounded out by Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey, who gives the following description of it:

* * "The fact is established that an excellent channel exists from sea to the sound (St. George's) running close in with the north shore of Dog island, with not less than twenty-one or twenty-two feet of water, (twenty or twenty-one feet at low water.")

"It is highly probable that deeper water may yet be found near the eastern end of the island."

"By this channel vessels may be carried from sea to a good anchorage in four fathoms, under a reef, and from there around the easternmost point and shoal of Dog island with not less than twenty-one or twenty-two feet, (twenty or twenty-one at low water,) as just stated. The general depth is four fathoms or more."

"On the bar of the east pass the depth at high tides is usually seventeen feet, never exceeding three fathoms."

* * * "Below are given directions for entering the new channel from sea, and for running into the four fathom anchorage under the reef. Beyond this it would not be safe to go without a pilot."

"*Directions.*—Bring Dog island light-house to bear west (by compass) and Southwest Cape NE. ½ N. On finding 5½ or 6 fathoms water, the course hence is north until the easternmost end of Dog island bears SW. by W. ½ W., or until the water shoals off the east point of Alligator harbor. From here haul up W.SW. and keep this course until well inside the reef, which can readily be discerned by colored water or breakers."

"Between Southwest Cape and the reef the channel now reported is very deep, having not less than thirty-one feet until well in towards the land, where soundings give four fathoms."

"To enter St. George's sound by this new pass a light-house on Southwest Cape will be indispensable, as well as another light on Dog island. A beacon should be placed at each point immediately."

The channel also should be marked by buoys.

I would respectfully request that a copy of this communication may be transmitted to the Light-house Board, and that authority be given to publish it in the usual form for the information of navigators.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 17.

Letter to the Secretary of the Treasury, communicating the discovery by Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, of several shoals near the passes of St. George's sound, and a new channel for entering the sound between St. George's and St. Vincent islands.

COAST SURVEY OFFICE, *May* 5, 1858.

SIR: I have the honor to communicate extracts from a report in reference to developments made in St. George's sound, western coast of Florida peninsula, by Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey.

The extracts show important special results obtained in the prosecution of the regular hydrography of that quarter, and contain, also, sailing directions for navigating a channel sounded out near Cape St. George light-house.

"I. The shoal off Cape St. George light-house (commonly designated as the 'Cape Shoal') is composed of detached reefs extending in a south and south by east direction from the light-house, with channels of various depths running between them. The only one, however, that can be recommended for navigation is about four miles from the land. This is quite wide, and the soundings in it vary from four fathoms to seventeen feet, the latter being the least water found. On the outer edge of it there are reefs having but ten or eleven feet on them, and on the inner edge others with but seven or eight feet. In both instances the water shoals very suddenly, and breaks unless the sea is very smooth.

"The end of this shoal is about six miles from the point of Cape St. George. There the water deepens to three fathoms, and by taking the channel coastwise vessels may save themselves great loss of time.

"The following directions will carry vessels through it:

"*Bound to the eastward.*—From the bar at the West Pass steer SE. (by compass) until the light-house on Cape St. George bears N. by W., then haul up east, and when in five fathoms the channel has been cleared.

"*Bound to the westward.*—When about four miles from the land, and in five fathoms water, get the light-house to bear N.NW., and steer east until it bears N. by W., then steer NW. and find four and a half fathoms. Continue on this course if bound to Apalachicola. When crossing the shoal the lead should be kept constantly going, as the set of the currents is always uncertain.

"This channel might be easily buoyed out. Two large buoys only would be requisite.

"II. Very near mid channel, and just inside the bar of the West Pass, there is a lump having only nine feet of water on it at the low tides which occur after a strong northerly wind. This is a continuation of a spit which puts out from the East Breakers, and there is deeper water between them and the lump.

"The following bearings show its position:

"Light-house on Cape St. George, bearing E. by S., (true.)

"Westernmost point of St. George's island, bearing NE. by E, (true.)

"III. Outside the West Breakers of the East Pass, and near the easternmost point of St. George's island, there is a shoal having upon it but fifteen or sixteen feet, while all around there is from three and a half to four and a half fathoms.

"Dog island light-house bears from it SW. ¼ S., (true,) and the east end of St. George's island S. by W. ¾ W."

Very respectfully yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 18.

Letter to the Secretary of the Treasury, communicating the development of dangers to navigation in San Francisco bay, California.

COAST SURVEY OFFICE, *June* 15, 1858.

SIR: I have the honor to report that a small rock off San Pablo Point, lying a little to the southward and westward of the "Brothers," and in the track of vessels going from San Francisco to Benicia, has been examined, and the vicinity sounded by Lieut. Comg. R. M.

Cuyler, U. S. N., Assistant in the Coast Survey. The following is an extract from a recent report made by that officer:

"The least water found was seventeen feet, but, as it was about the time of high water, four or five feet should be deducted. To be on the safe side I have put down the depth as twelve feet at mean low water, and have marked the spot 'Whiting's Rock' on the tracing which accompanies my report."

"It is small and might easily escape detection in soundings."

"I took the occasion also to look for a reef on the Contra Costa flats, the existence of which had been reported to me several weeks before, and after three attempts found it. At very low tides this reef is bare, and would probably be only covered at mean low water."

The positions of the two dangers to navigation mentioned above have been marked on the charts of San Pablo and San Francisco bays, the engraving of which is now in progress.

I would respectfully request authority to publish this letter in the form of a notice to mariners.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 19.

Report of Captain W. R. Palmer, U. S. Topographical Engineers, Assistant in charge of the Coast Survey office, and extracts from sub-reports of chiefs of the office divisions.

COAST SURVEY OFFICE, *October* 1, 1858.

DEAR SIR: I have the honor to submit herewith the annual reports of the chiefs of the various divisions of this office, showing the details of work executed in each since the 1st of November, 1857.

Captain M. L. Smith, corps of topographical engineers, U. S. A., continued in charge of this office, assisted by 1st Lieutenant A. P. Hill, 1st artillery, until the 18th of May last. Your instructions of that date assigned these officers to other duty connected with the survey, and I was directed to assume the charge of this office, that is, for the last four months; 1st Lieutenant J. P. Roy, 2d infantry, was assigned as general assistant in the office.

The merits and capacity of my predecessor, and of 1st Lieutenant Hill, are so well known to you that it is unnecessary for me to advert to them.

A detailed statement of the results produced, showing the share of each employé of the office in its labors, will be found in the reports of the chiefs of the divisions, hereto annexed, in the order in which I shall name them. I do not present to you at this time any extended notice of the work of any one division, as the clear and elaborate report of Captain Smith of the last year seems to render this unnecessary, and particularly as I have been in charge of the office for so short a period. I would, however, observe that in my judgment this office has maintained the efficiency that has been so highly and properly commended by each of my predecessors, and as very few changes have been made in its personnel, a steady improvement is manifested in the results obtained.

Computing Division.—This division is under the charge of Assistant C. A. Schott; the ability, industry, and strict attention to duty that characterize its chief are rarely equalled. I regret to add that his health suffers at this time from the confinement to which his duties have subjected him. Its numbers have remained the same as during the past year, enabling it to meet all the demands made upon it, viz: furnishing data for the charts and to parties in the field, and also information to persons not connected with the survey, (on their application, which is only communicated under the authority of the Treasury Department,) besides its regular duties of computing, comparing and adjusting the primary, secondary, and tertiary triangulations; the measurements of bases; astronomical, chronometric and magnetic observations, &c.; each of these calculations being twice and often thrice revised, and re-examined by separate computers, thus insuring in all cases the greatest possible accuracy.

The report of Assistant C. A. Schott is hereto appended.

Tidal Division.—The chief of this division, Assistant L. F. Pourtales, reports direct to the Superintendent, by whom its operations are immediately controlled. Assistant Pourtales' report will be found in Appendix No. 29.

Drawing Division.—The drawing division, under the experienced and able management of 1st Lieutenant J. C. Tidball, 2d artillery, who has had continuous charge of it since August, 1855, now more than three years, has made considerable improvement in its progress over that of previous years. The force, although comparatively small, has not only gained in its advanced supply of work for the increased number of engravers, but has also furnished the drawings for the lithographers, and met with promptness all demands made upon it for projections, tracings, &c. The annexed report of Lieutenant Tidball, and the lists accompanying it, specify in detail the work executed by each draughtsman, and the progress made during the year.

Engraving Division.—This division consists at this time of one chief engraver, nineteen engravers, and one apprentice. The work executed upon our first class finished charts, cannot, it is believed, be excelled in skill and beauty by engravers of the highest reputation in this or any other country known to the art.

First Lieutenant Rufus Saxton, 4th artillery, who has been in charge of this division since June, 1856, has with success devoted great attention and energy to its judicious management. His report of the maps, charts and sketches engraved during the year, with the accompanying lists hereto appended, will exhibit in detail the character and amount of work executed by each of the engravers.

Electrotype Division.—Under the skilful management of Mr. George Mathiot, the electrotypist of this office, ninety-five plates have been made this year, being eleven more than the number produced during the last, and greatly exceeding that of any previous year. Of these forty-six were in alto and forty-nine in basso; in addition to this ten plates have been altered and extended by the electrotype process.

Mr. Mathiot has also with increased success devoted a portion of his time to making interesting experiments in photography, especially with a view to its use in the preparation of the reductions from the original plane-table sheets. His report is annexed.

Miscellaneous division.—This division has been organized since the date of the last report, and has already improved in efficiency under the charge of Lieut. J. P. Roy, as compared with its former separate working. It comprises the printing and distribution of maps, charts, and Coast Survey reports. The annexed report of Lieut. Roy, and subjoined statements, will show its operations since the 1st of November, 1857.

Archives and library.—This branch of the office is continued under the charge of Mr. C. B. Snow, by whom the duties connected therewith are satisfactorily performed.

My predecessor, in his annual report of last year, called attention to the great inconvenience that would be felt if a larger space for a depository for the archives and books was not shortly provided. Since then upwards of one thousand volumes of records and nearly one hundred and fifty plane-table sheets have been added to the vast amount then on deposit in the small room occupied for that purpose. This inconvenience is now felt, and increases with the constant accumulation of the archives in the survey.

During the year one hundred and six volumes have been added to the library, of which twenty-four were presented by foreign governments and scientific societies, and eighty-two purchased. The library consists at this time of nearly three thousand volumes.

Instrument shop.—The labors of this division of the office are satisfactorily performed under the charge of Mr. J. Vierbuchen, master instrument maker. * * * *

The following number of instruments of the several classes named have been made within the year: Fifteen for geodesy; seven for astronomical observations, (parts of instruments;) one for magnetic observations; forty-four for topography; forty-one for hydrographic purposes; sixteen for drawing; one hundred and thirteen tools; and fifteen implements for miscellaneous purposes.

The following have been repaired: Thirty-seven geodetic instruments; ten astronomical instruments; four magnetic; forty topographical; forty hydrographic; and fifteen drawing instruments.

In the shop the force consists of five instrument makers and a blacksmith.

Carpentry.—The implements and appliances needed for the use and transportation of the instruments employed in the field and afloat have been made as occasion required. Of these, thirty-six pieces of work were for geodetic or topographical purposes, exclusive of fifteen chests and packing boxes. Two tide-gauges have been made, and for office use three scales and a board for reading the tidal registers, in addition to ninety-five pieces, as cases, desks, tables, frames, and drawing boards; and a hundred and sixty-two tubes have been painted and marked for filing original maps and charts. A portico has been put up and glazed, and a large camera made for photographic purposes, besides thirty-six frames and boxes for the electrotype laboratory. * * * * * * * * * * *

The faithfulness and skill with which the work is carried on by Mr. A. Yeatman, the master carpenter, merits commendation. He is assisted by one carpenter and one apprentice.

In closing this report it becomes equally a pleasure and a duty to acknowledge the valuable services of Lieut. J. P. Roy, general assistant, upon whom, in the absence of the assistant in charge, the administration of the details of the office devolves, in addition to his other special and regular duties.

It is also my duty to express myself in the highest terms of the manner in which the varied clerical duties are performed by Mr. A. W. Russell, the principal clerk of the assistant in charge.

I have the honor to be, very respectfully, your obedient servant,

W. R. PALMER,

Capt. Top. Eng'rs, Assistant in charge of Office Coast Survey.

Prof. A. D. BACHE,

Superintendent U. S. Coast Survey.

Report of Assistant Charles A. Schott, in charge of the Computing Division.

COAST SURVEY OFFICE, *October* 1, 1858.

Agreeably to the regulations of the office, I herewith respectfully submit the annual report of the result of the labors of the several computers for the year ending October 1, 1858.

The number of the computers has been the same as last year; the opening occasioned by Mr. Blankenship's resignation has been filled by Mr. W. D. Storke, who reported for duty December 22, 1857. No temporary assistance was had or required during the year.

A smaller amount of field-work was received by the division than in former years, in consequence of which one of the computers was temporarily transferred to assist in the work of the publication of records and results. As another consequence, a more frequent application has been made of the method of least squares, and thus the desired accuracy obtained at once. In addition, all results now far enough advanced have been put in proper shape for publication.

The general distribution of the different kinds of computations, and the amount of work done by each computer, will be seen from the following detailed statements.

Besides attending to the ordinary duties of the division, the following subjects have received my particular attention, and reports have been made in reference to them. The station error in azimuth; the result of a preliminary investigation and reduction of the arc of a meridian measured in the Eastern States; the result of the reduction of the primary base lines at Cape Sable and on Epping Plains; and the result of an investigation of the co-efficient of expansion of the standard base bar. With the assistance of a computer, certain secondary triangulations in Section I, of 1849, and the primary triangulation of Section IV, have been adjusted and reduced by the method of least squares. The magnetic reductions in general have been kept up to date.

Assistant Theodore W. Werner completed the reduction of the triangulation south of Tybee, (1857;) reduced the Matagorda bay triangulation, (1857;) also, that in the vicinity of San Pedro in California, including Assistant Greenwell's latest work. He reduced Lieut. Seward's triangulation on the Florida reef, (1856–'57,) and Assistant Davidson's additional work (1857) on Admiralty inlet. He completed the latitude computations of station Columbia, occupied by Dr. Gould; supplied the L. M. Z. to the Cumberland Sound triangulation, including Capt. Simpson's work near Fernandina; and reduced the triangulation forming the connexion between Charleston harbor and Winyah bay.

Mr. Eugene Nulty completed the reduction of the chronometric longitude of Fernandina, and after reducing the latitude of Presidio was supplied with work by the party in charge of the publication of the records from November 13, 1857, to June 1, 1858. He has since made the second reduction of the latitude of Columbia, and made progress with the reduction of the Z. T. latitude of Calais, Me., (1857.)

Mr. James Main revised the latitude computations of Mt. Harris; was engaged in the collection of elevations; attended to miscellaneous computations; revised the latitude of Mt. Desert, and the longitude computations of Fernandina, Fla. He reduced the magnetic observations of 1857 in Sections I and VIII; revised the azimuth of Unkonoonuc; made some reductions for time; revised the azimuth of Mt. Pleasant, Soper and Hill station; also of Deer island and Hurricane island; reduced three moon culminations observed at Hudson, Washington Territory; and completed the azimuth revision of stations Bodies island, Stevenson's Point, and Dollar Point. He also reduced the magnetic observations made at the Dudley Observatory, and at New Orleans.

Mr. Gottleib Rumpf attended to the insertion of the geographical positions in the registers; completed L. M. Z. of a part of the triangulation in Section VIII; reduced Assistant Blunt's new triangulation in the vicinity of New York, a computation of considerable extent, including also the reduction of the (1854) Hudson river triangulation; attended to the preparation of the annual statistics; reduced the triangulation of Hudson river (1857;) and made some least square reduction of the Mobile bay triangulation.

Mr. John Weissner completed the first set of L. M. Z. to Capt. Simpson's and Lieut. Evans' triangulation near the St. Mary's river, and also some new positions in Section I; assisted in the preparation of the geographical positions for the report; completed the reduction of the Atchafalaya bay triangulation of 1855 and 1856, including that of Côte Blanche bay; revised abstracts of horizontal angles of the primary triangulation in Section IV; reduced the Patuxent river work of Lieut. Roy's, and the St. George's sound triangulation in Section VII as far as S. W. Cape; calculated the length of the new base at Cedar Key; assisted me in the least square reduction of the primary triangulation of Sections I and IV, and also of Section III; reduced the latitude of Deer island; assisted occasionally on the L. M. Z. reductions of New York, and made progress in the reduction of Lieut. Seward's triangulation near Cape Sable base.

Mr. W. D. Storke after making himself familiar with our methods of reduction, assisted Mr. Rumpf on his L. M. Z. calculations of New York; performed some miscellaneous duties referring to measures of areas and positions; supplied the Cedar Key and Wacassassa bay with L. M. Z.; reduced the small triangulation of Curratoman river, Section III; assisted on the reduction of the Atchafalaya and Côte Blanche bay work, and on the preparation of statistics; and reduced Lieut. Evans' triangulation between Ossabaw and Sapelo sound, including the supply of L. M. Z. to the latter locality.

Mr. John T. Hoover attended to the clerical duties of the division, and assisted on the revision of the geographical positions for the report of 1857.

Report of Assistant L. F. Pourtales, in charge of Tidal Division.

COAST SURVEY OFFICE, *October* 1, 1858.

The following report on the occupation of the computers in this division during the past year is respectfully submitted:

Mr. R. S. Avery has continued to discuss the Boston tidal observations with a view to preparing tables of predictions. He has also treated, by the same method, a series of the tides of San Diego bay, Cal.

Mr. S. Walker has been engaged during part of the year in making graphical decompositions of the tidal curves from the Florida reef. He is now employed in reading off the sheets of the self-registering tide-gauges, and has charge of the correspondence with the observers and of the lists of receipts of observations.

Mr. J. Downes joined the division, from Assistant J. E. Hilgard's party, on January 1, and has plotted and decomposed graphically the tidal curves from the Florida reef.

Mr. G. C. Blanchard made ordinary reductions of tides and copies of reports, &c., until March 8, when he left the office.

Mr. R. E. Evans was temporarily attached to this division until the end of November, 1857, and again in May and June when not employed on field duty. He made ordinary reductions and readings from the self-registering tide-sheets.

Mr. C. Fendall was employed during the month of May in comparing simultaneous observations of tides in the waters of San Francisco bay, Cal.

Mr. D. Trueheart assisted Mr. Avery in his discussion of the Boston tides from June 28 to August 31.

The meteorological observations made by the tidal observers on the Western Coast have been reduced, as heretofore, by *M. Thomas*, and the tidal observations of the permanent stations have been reduced since the month of May by *S. D. Pendleton.*

Report of Lieut. J. C. Tidball, U. S. A., assistant in charge of the Drawing Division.

COAST SURVEY OFFICE, *November* 1, 1858.

This division has remained under my charge during the past year, and Mr. G. A. Porterfield has continued to assist me in the performance of my duties.

The following statement of work executed by draughtsmen, and the different lists accompanying this report, will show the progress made by the division during the year:

Assistant W. M. C. Fairfax has been employed upon the reduction of the topography of Cape Cod bay and the coast of Massachusetts from Plymouth to Hyannis, scale $\frac{1}{80000}$; coast of South Carolina, including Charleston harbor and vicinity, $\frac{1}{80000}$; and Florida reefs and keys, from Virginia key to Lower Matecumbe key, also Key West and vicinity, $\frac{1}{60000}$.

Assistant M. J. McClery has made additions to the Congress map, $\frac{1}{1500000}$; and has been employed in reducing the topography of Massachusetts bay, $\frac{1}{80000}$; and that of the coast of Massachusetts, from Portsmouth to Cape Ann, $\frac{1}{80000}$. He has commenced the topography of off-shore charts: No. IV, from Cape May to Currituck sound, $\frac{1}{400000}$; and No. V, from Currituck sound to Cape Fear, $\frac{1}{400000}$.

Mr. James J. Ricketts was employed upon the hydrography of off-shore chart No. II, from Cape Ann to Gay Head, $\frac{1}{400000}$; and Chesapeake bay, No. 4, from Potomac river entrance to the entrance of Pocomoke sound, $\frac{1}{80000}$, until the first of February, when he tendered his resignation, which was accepted by the Superintendent.

Mr. A. Boschke has been in charge of the making of projects of maps and charts.

Mr. L. D. Williams has been engaged upon preliminary charts: No. 3, from Portland to Cape Cod, $\frac{1}{200000}$; No. 12, from Cape Lookout to Cape Fear, $\frac{1}{200000}$; Nos. 19 and 20, Florida reefs and keys, from Virginia key to the westward of the Tortugas, $\frac{1}{200000}$; No. 26, from Mobile bay to Lake Pontchartrain, inclusive, $\frac{1}{200000}$; and off-shore chart No. II, from Cape Ann to Gay Head, $\frac{1}{400000}$. He has also made additions to the Congress map, $\frac{1}{1500000}$; projections on copper, and verifications.

Mr. A. Lindenkohl has drawn the preliminary chart of Monterey bay, $\frac{1}{60000}$; reduced the topography of San Pablo bay, $\frac{1}{50000}$; prepared maps of the Florida keys for the General Land Office, and has also been employed upon the lower sheet of Rappahannock river, from Punch Bowl to the entrance, $\frac{1}{60000}$; and those of San Francisco bay and vicinity, $\frac{1}{80000}$.

Mr. A. Balbach has made comparative charts of the Cape Fear entrances, $\frac{1}{10000}$; completed the hydrography of Chesapeake bay, No. 2, from Magothy river to Chester river, $\frac{1}{80000}$; and has been engaged in reducing the hydrography of Massachusetts bay, $\frac{1}{80000}$; New York bay and harbor, $\frac{1}{80000}$; Chesapeake bay, No. 4, from Potomac River entrance to the entrance of Pocomoke sound, $\frac{1}{80000}$; and also in verifications, examinations, and corrections of original hydrographic work.

Mr. W. P. Schulz has reduced the hydrography of Matagorda entrance, $\frac{1}{40000}$, and has been employed upon progress sketches, projects, and projections.

Mr. A. Strausz has completed the reduction of the hydrography of St. Helena sound, $\frac{1}{40000}$; plotted original hydrographic sheets of Rappahannock river from Urbanna to the entrance; and has been engaged upon the reduction of the hydrography of Chesapeake bay, Nos. 5 and 6, from Pocomoke sound to the entrance of the bay, $\frac{1}{80000}$.

Mr. W. T. Martin has been occupied in drawing the topography and hydrography of Mississippi sound, Nos. 2 and 3, from Round island to Lake Pontchartrain, $\frac{1}{80000}$; in drawing topography for charts of the coast of Texas, Nos. 106 and 107, from Galveston bay to Matagorda bay, $\frac{1}{80000}$; and for that of the Florida reefs from Garden cove to Lower Matecumbe key, $\frac{1}{80000}$.

Mr. P. Witzel has reduced the maps of St. Mary's river and Fernandina harbor, $\frac{1}{20000}$; Pensacola bay, $\frac{1}{80000}$; Bull's bay, $\frac{1}{40000}$; St. Simon's sound and Brunswick harbor, $\frac{1}{40000}$; and Rockport harbor, $\frac{1}{20000}$. He has completed the topographical drawing of Chesapeake bay, No. 2, $\frac{1}{80000}$; additions to San Francisco bay, $\frac{1}{50000}$; and York river, Va., (lower sheet,) $\frac{1}{60000}$; and has been employed upon the upper sheet of York river, Va., $\frac{1}{60000}$; on progress sketches, projections, projections on copper, and miscellaneous work.

Mr. F. Fairfax has reduced the hydrography of Semiahmoo bay, $\frac{1}{30000}$; Humboldt bay, $\frac{1}{30000}$; and has made a comparative chart of St. John's entrance, $\frac{1}{10000}$; and tracings of topographical sheets for photographic experiments. He has been engaged, also, in reducing the topography of the upper sheet of James river, Va., $\frac{1}{60000}$.

Mr. B. Hooe has copied the plane-table sheets of the Florida keys for the General Land Office, and has been continued upon tracings.

Artificer J. A. Campbell, U. S. A., has been continued upon tracings, and in charge of the miscellaneous maps.

Mr. S. B. Linton has drawn the sketch of co-tidal lines of the Atlantic coast, and has been engaged upon titles and general lettering, and on progress sketches and projections.

Mr. W. T. Bright has drawn the diagrams showing the lines of descent in deep-sea soundings, diagrams of currents in New York Harbor entrance, and additions to the progress sketches.

Mr. A. Schoepf, on contract, has reduced the hydrographic chart of Hatteras inlet, $\frac{1}{20000}$, and that of Ocracoke inlet, $\frac{1}{30000}$.

List of maps and sketches completed, or in progress, during the year ending November 1, 1858, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.—*Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*			
Progress sketch A	1–600,000		Completed.
Progress sketch A *bis*	1–400,000		Do.
Epping Plains base, Maine	1–20,000	Sketch	Do.
Seacoast of Maine, New Hampshire, and Massachusetts, from Portland to Cape Cod	1–200,000	Preliminary chart	In progress.
Coast of New Hampshire and Massachusetts, from Portsmouth to Cape Ann	1–80,000	Finished map	Do.
Rockport harbor, Massachusetts	1–20,000	do	Completed.
General coast chart No. II, from Cape Ann to Gay Head, Massachusetts	1–400,000	Finished chart	In progress.
Massachusetts bay and coast, from Cape Ann to near Plymouth	1–80,000	Finished map	Do.
Cape Cod bay and coast of Massachusetts, from Plymouth to Hyannis	1–80,000	do	Do.
SECTION II.—*Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware, north of Cape Henlopen.*			
Progress sketch B	1–400,000		Completed.
New York bay and harbor	1–80,000	Finished map	In progress
Diagrams showing velocity of currents in and near New York harbor entrance		Diagrams	Completed.
Sketch showing current stations occupied in and near New York harbor entrance		Sketch	Do.
Sketches showing set of currents in Sandy Hook bay		Sketches	Do.
SECTION III.—*Coast of Delaware, south of Cape Henlopen, Maryland and Virginia, north of Cape Henry*			
Progress sketch C	1–400,000		Completed.
General coast chart No. IV, from Cape May, New Jersey, to Currituck sound, North Carolina	1–400,000	Finished chart	In progress.
Chesapeake bay, No. 2, from Magothy river to Chester river, Maryland	1–80,000	Finished map	Completed.
Chesapeake bay, No. 3, from Hudson river to Potomac river, Maryland	1–80,000	do	In progress.
Chesapeake bay, No. 4, from Potomac river entrance to entrance of Pocomoke sound, Maryland and Virginia	1–80,000	do	Do.
Chesapeake bay, No. 5, from entrance of Pocomoke sound to York spit, Virginia	1–80,000	do	Do.
Chesapeake bay, No. 6, from York spit to Cape Henry, Virginia	1–80,000	do	Do.
Rappahannock river, No. 5, from Occupacia creek to Punch Bowl, Virginia	1–60,000	do	Do.
Rappahannock river, No. 6, from near Punch Bowl to entrance, Virginia	1–60,000	do	Do.
York river, from West Point to King's creek, Virginia	1–60,000	do	Do.
York river, from King's creek to entrance, Virginia	1–60,000	do	Completed.
James river, from Richmond to City point, Virginia	1–40,000	do	In progress.
SECTION IV.—*Coast of Virginia south of Cape Henry, and North Carolina, north of Cape Fear.*			
Progress sketch D	1–400,000		Completed.
General coast chart, No. V, from Currituck sound to Cape Fear, North Carolina	1–400,000	Finished chart	In progress.
Hatteras inlet, North Carolina	1–20,000	Sketch	Completed.
Ocracoke inlet, North Carolina	1–30,000	Sketch	Do.
Seacoast of North Carolina from Cape Hatteras to Cape Lookout	1–200,000	Preliminary chart	In progress.
Seacoast of North Carolina from Cape Lookout to Cape Fear	1–200,000	do	Do.
New inlet, Cape Fear river, North Carolina	1–10,000	Comparative chart, 1857 to '58	Completed.
Cape Fear river entrance, North Carolina	1–10,000	do do	Do.

List of maps and sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION V.—*Coast of North Carolina south of Cape Fear, of South Carolina and Georgia*			
Progress sketch E	1-600,000		Completed.
Bull's bay, South Carolina	1-40,000	Preliminary chart	Do.
Coast of South Carolina, from Rattlesnake shoal to St. Helena sound	1-80,000	Finished map	In progress.
Charleston harbor, (resurvey of city,) South Carolina	1-30,000	do	Completed.
St. Helena sound, South Carolina	1-40,000	Preliminary chart	Do.
St. Simon's sound and Brunswick harbor, Georgia	1-40,000	do	Do.
St. Mary's river, and Fernandina harbor, Georgia and Florida	1-20,000	Finished map	Do.
SECTION VI.—*Coast of Florida, from St. Mary's river to St. Joseph's bay.*			
Progress sketch F, (showing Captain Simpson's reconnaissance and a general reconnaissance of the coast)	1-1,200,000		Completed.
Progress sketch F, No. 2, (Florida reefs and keys)	1-400,000		Do.
St. John's entrance and river to Mayport mills	1-10,000	Comparative chart, 1853 to '57	Do.
Florida reefs and keys, from Bahia Honda to Tortugas, (part of charts 19 and 20)	1-200,000	Preliminary charts	In progress.
Florida reefs and keys, from head of Key Biscayne to Marquesas key, (coast charts 68, 69, 70, and 72)	1-80,000	Finished charts	Do.
SECTION VII.—*Coast of Florida west of St. Joseph's bay, and Alabama east of Mobile bay.*			
Progress sketch G	1-600,000		Completed.
Pensacola harbor, Florida	1-30,000	Finished map	Do.
SECTION VIII.—*Coast of Alabama west of Mobile bay, of Mississippi and Louisiana east of Vermilion bay.*			
Progress sketch H	1-600,000		Completed.
Seacoast of Mississippi and Louisiana from Mobile bay to Lake Pontchartrain	1-200,000	Preliminary chart	In progress.
Mississippi sound, from Round island to Grand island, Mississippi	1-80,000	Finished map	Do.
Mississippi sound, from Grand island to Lake Pontchartrain, Louisiana	1-80,000	do	Do.
SECTION IX.—*Coast of Louisiana west of Vermilion bay, and of Texas.*			
Progress sketch I	1-600,000		Completed.
Galveston bay and vicinity, Texas	1-80,000	Finished map	In progress.
Coast of Texas from Galveston bay to San Luis pass	1-80,000	do	Do.
Matagorda bay entrance, Texas	1-40,000	do	Completed.
SECTION X.—*Coast of California.*			
Progress sketch J, from San Diego to Point Sal	1-600,000		Completed.
Progress sketch J, No. 2, from Point Sal to Tomales bay	1-600,000		Do.
Monterey bay	1-60,000	Preliminary chart	Do.
San Francisco entrance, (additions)	1-50,000	Finished map	Do.
San Francisco bay	1-80,000	do	In progress.
San Pablo bay	1-50,000	do	Completed.
Humboldt bay	1-30,000	do	Do.
SECTION XI.—*Coast of Oregon and Washington Territories.*			
Progress sketch K	1-600,000		Completed.
Canal de Haro and strait of Rosario, (additions,) Washington Territory	1-200,000	Sketch	Do.
Port Gamble, Washington Territory	1-20,000	Finished map	Do.
Semiahmoo bay, Washington Territory	1-30,000	Sketch	Do.
Sand's sounding apparatus		Sketch	Completed.
Berryman's improvement on Brook's sounding apparatus		do	Do.
Mitchell's tide-gauge for deep water		do	Do.
Trenchard's tide-gauge		do	Do.
Chronometer changes for difference of longitude		Diagrams	Do.
Curves illustrating the descent of weight and line in deep-sea soundings		do	Do.
Scheme of preliminary and finished charts		Sketch	Do.

Report of First Lieutenant Rufus Saxton, 4th regiment of Artillery, United States army, Assistant in charge of the Engraving Division.

COAST SURVEY OFFICE, *September* 30, 1858.

I have the honor to present the annual report of the operations of this division, which has been under my charge during the present year. No change has taken place in its organization since my last report.

The great amount of labor attendant upon a judicious arrangement of the various details of the engraving needs but to be understood to be appreciated. In conducting the affairs of the division one object has been kept steadily in view, that of giving to the Coast Survey maps and charts a form pleasing to the eye, as well as accuracy, and to make such an arrangement of the different parts that the whole should meet with the approval of correct taste. It is proper to mention here that much of whatever success has been attained in this regard is to be attributed to the efficient aid rendered by my assistant Mr. Edward Wharton.

The engraving force now consists of one chief engraver, nineteen assistants, and one apprentice.

The engraving of the finished maps of Annis Squam and Ipswich harbors, Provincetown harbor, Wood's Hole harbor, York river entrance, Beaufort harbor, N. C., Cape Fear river, and San Diego bay has been completed during the year.

The first class finished maps and charts of coast charts, Nos. 12 and 13, $\frac{1}{80000}$, series; Chesapeake bay series, Nos. 1, 2, and 3, $\frac{1}{80000}$; Pensacola harbor; coast charts, Nos. 91 and 92, $\frac{1}{80000}$; San Francisco bay, and San Pablo bay have been in the hands of first class engravers, and give promise of valuable results in the future.

Mr. McCoy has engraved topography upon coast chart, No. 3, $\frac{1}{80000}$; outlines of Chesapeake bay, No. 3, $\frac{1}{80000}$, series; retouched the views upon the Western Coast charts and miscellaneous work; *Mr. Dankworth* has engraved outlines and topography upon the Chesapeake bay series, Nos. 1 and 2, $\frac{1}{80000}$; *Mr. Enthoffer* has engraved the topography of part of coast chart, No. 13, $\frac{1}{80000}$; San Diego bay, and commenced that of Chesapeake bay, No. 3, $\frac{1}{80000}$; *Mr. Knight* has been employed on the titles, notes, soundings, and miscellaneous lettering of coast chart, No. 13, $\frac{1}{80000}$; Chesapeake bay series, Nos. 1, 2, and 3, $\frac{1}{80000}$; and San Diego bay; *Mr. Rollé* has engraved the topography of part of the map of Patapsco river and Chesapeake bay, No. 1, $\frac{1}{80000}$; *Mr. Sengteller* has completed the topography of Provincetown harbor; coast chart, No. 4, $\frac{1}{80000}$; and commenced that of coast chart, No. 12, $\frac{1}{80000}$; *Mr. Metzeroth* has finished the topography of Annis Squam and Ipswich harbor; Beaufort harbor; and also engraved a portion of Rappahannock river; Pensacola harbor; and Monterey bay charts; *Mr. Blondeau* has been employed the entire year in engraving the topography of San Francisco bay and harbor map; *Mr. Phillips* has engraved a portion of the topography coast charts, Nos. 91 and 92, $\frac{1}{80000}$; *Mr. E. A. Maedel* has engraved a portion of the topography of Wood's Hole harbor, and Biloxi, and titles, notes, soundings, and general lettering upon the plates of Provincetown harbor; Rappahannock river; seacoast of the United States, Nos. 3, 4, 11, 14, and 31, $\frac{1}{200000}$, series, and other miscellaneous work; *Mr. Throop* has engraved soundings and miscellaneous lettering upon the maps of Beaufort harbor; Cape Fear river coast charts, Nos. 41 and 42, $\frac{1}{80000}$; seacoast of the United States, No. 31, $\frac{1}{200000}$; and other miscellaneous work upon charts and sketches; *Mr. Kondrup* has finished the outlines upon the maps of Chesapeake bay, Nos. 1 and 2, $\frac{1}{80000}$, series; and the title and soundings of San Diego bay; and commenced the soundings and general lettering upon the seacoast chart of the United States, No. 26, $\frac{1}{200000}$; *Mr. Maedel* has completed the topography of Cape Fear river; the outlines, soundings, and general lettering of St. Mary's river and Fernandina harbor; ***Mr. Barnard*** has engraved sanding upon Annis Squam and Ipswich harbor; York river; seacoast of the United States, No. 11, $\frac{1}{2000000}$; coast chart, No. 41, $\frac{1}{80000}$; and a small quantity of topography upon the plate of St. John's river; ***Mr. Langran*** has engraved soundings and general lettering upon the charts of Rappahannock and York rivers; seacoast of the United States, Nos. 13 and 14, $\frac{1}{2000000}$; and Legarè anchorage; ***Mr. Ogilvie*** has continued the soundings, sanding, and general lettering of the seacoast of the United States, Nos. 3 and 4, $\frac{1}{2000000}$; ***Mr. Petersen*** has finished the topography and general lettering of the map of Wood's Hole; the lettering and soundings of Annis Squam and Ipswich harbor; seacoast of the United States, No. 3, $\frac{1}{2000000}$; and St. Simon's sound; and Brunswick harbor; ***Mr. Bartle*** has completed the sketch of San Antonio creek, and done miscellaneous work upon maps, charts, and progress sketches; ***Messrs. Benner*** and *Thompson*, and apprentice *Sipe* have been employed in the engraving of the progress and other sketches, and such miscellaneous work as suited their capability, or was calculated to improve their knowledge of the art.

The smallness of the engraving force, in comparison with the amount of work to be done, has again involved the necessity of lithographing or engraving upon stone a portion of the sketches for the Superintendent's report of 1857. As economy is the order of the day in this office, I would call your attention to the propriety of increasing this list for the report of 1858.

A more detailed account of the work performed, progress made, &c., can be found in the accompanying list of maps, charts, preliminary charts, and sketches engraved or engraving during the year, arranged in the order of sections for the year ending November 1, 1858, and in the complete list of Coast Survey maps, charts, preliminary charts, and sketches engraved and arranged geographically.

List of maps, preliminary charts, and sketches, engraved or engraving, during the year ending October 1, 1858—*arranged in order of sections.*

Name.	Scale.	Description.	Remarks.
SECTION I.			
Progress sketch A	1–400,000		Engraved.
Do A, *bis*	1–600,000		Do.
°Epping base, (*profiles and cross sections*)	1–20,000	Sketch	Do.
°Kennebec river entrance	1–30,000	Preliminary chart	Do.
Seacoast of the United States, No. 3, Maine, New Hampshire, and part of Massachusetts	1–200,000	do	Engraving.
Ipswich and Annis Squam harbors	1–20,000	Finished chart	Engraved.
Monomoy shoals, (new edition)	1–40,000	do	Engraving.
Muskeget channel	1–60,000	do	Do.
Seacoast of the United States No. 4, southern part of Mass.	1–200,000	Preliminary chart	Engraved.
Provincetown harbor	1–50,000	Finished chart	Do.
Harbor of Wood's Hole	1–20,000	do	Do.
Coast chart No. 12, (eastern series No. 3)	1–80,000	do	Engraving.
Do No. 13, (do No. 2)	1–80,000	do	Do.
Do No. 14, (do No. 1)	1–80,000	do	Do.
SECTION II.			
Progress, Hudson river triangulation	1–400,000		Engraved.
°New York bay and harbor	1–80,000	Preliminary chart	Do.
SECTION III.			
Progress sketch C	1–400,000		Engraved.
Chesapeake bay, upper series, sheet No. 1	1–80,000	Finished chart	Engraving.
Do do No. 2	1–80,000	do	Do.
Do do No. 3	1–80,000	do	Do.
Do do No. 1	1–80,000	Preliminary chart	Engraved.
Do do No. 2	1–80,000	do	Do.
Do do No. 3	1–80,000	do	Do.
Do lower series No. 1	1–80,000	Finished chart	Engraving.
Patapsco river	1–60,000	do	Do.
Rappahannock river, from entrance to Deep creek	1–60,000	Preliminary chart	Engraved.
Rappahannock river, from Deep creek to Occupacia creek	1–60,000	do	Do.
York river, Virginia	1–60,000	Finished chart	Do.
° Hampton roads and Elizabeth river	1–40,000	Preliminary chart	Do.
° Norfolk harbor	1–10,000	do	Do.
SECTION IV.			
Progress sketch D	1–400,000		Engraved.
Seacoast of the United States, No. 11, North Carolina	1–200,000	Preliminary chart	Engraving.
Hatteras and Ocracoke inlets	1–20,000 1–30,000	Sketch	Engraved.
Coast chart, No. 41, (Albemarle sound, No. 1)	1–80,000	Finished chart	Engraving.
Coast chart, No. 42, (Albemarle sound, No. 2)	1–30,000	do	Do.
Beaufort harbor, North Carolina, (on steel)	1–20,000	do	Engraved.
Do do do	1–10,000	Comparative chart	Do.
SECTION V.			
Progress sketch E	1–600,000		Engraved.
Entrances to Cape Fear river	1–30,000	Preliminary chart	Do.
° Entrances to Cape Fear river	1–10,000	Comparative chart	Do.
Seacoast of the United States, No. 14, South Carolina	1–200,000	Preliminary chart	Do.
° Bull's bay and Roman inlet	1–40,000	do	Do.
° St. Helena sound	1–40,000	do	Do.
St. Simon's sound and Brunswick harbor	1–40,000	do	Do.
St. Mary's river and Fernandina harbor	1–20,000	do	Do.
SECTION VI.			
Progress sketch F	1–200,000		Engraved.
Progress sketch F, lower sheet, Florida keys	1–400,000		Do.
St. John's river entrance	1–10,000	Comparative chart	Do.
Seacoast of the United States, No. 19, Florida reefs	1–200,000	Preliminary chart	Engraving.
Legaré anchorage, (additions and changes)	1–20,000	Sketch	Engraved.

List of maps, preliminary charts, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION VII.			
Progress sketch G	1-600,000		Engraved.
° Apalachicola river entrance	1-20,000	Preliminary chart	Do.
Pensacola harbor entrance	1-30,000	do	Do.
SECTION VIII.			
Progress sketch H	1-600,000		Engraved.
Coast chart, No. 91, (Mississippi sound, No. 1)	1-80,000	Finished chart	Engraving.
Coast chart, No. 92, (Mississippi sound, No. 2)	1-80,000	do	Do.
Seacoast of the United States, No. 26, part of Alabama and Mississippi	1, 200,000	Preliminary chart	Do.
Biloxi bay	1-40,000	Finished chart	Do.
° Mississippi City harbor	1-40,000	Preliminary chart	Engraved.
° St. Louis bay and Shieldsboro' harbor	1-30,000	do	Do.
° Grand Island Pass	1-40,000	do	Do.
SECTION IX.			
Progress sketch I	1-600,000		Engraved.
Seacoast of the United States, No. 31, part of Texas	1-200,000	Preliminary chart	Do.
° Entrance to Matagorda bay	1-40,000	do	Do.
SECTION X.			
Progress sketch J, lower sheet	1-600,000		Engraved.
Progress sketch J, middle sheet	1-600,000		Do.
San Diego bay	1-40,000	Finished chart	Do.
Eastern entrance to Santa Barbara channel	1-80,000	Preliminary chart	Do.
Monterey bay	1-60,000	do	Do.
Entrance to San Francisco bay, California	1-50,000	Finished chart	Engraving.
Mare Island straits	1-30,000	do	Engraved.
San Antonio creek	1-20,000	Preliminary chart	Do.
San Pablo bay	1-50,000	Finished chart	Engraving.
SECTION XI.			
Progress sketch K	1-600,000		Engraved.
Miscellaneous.			
Project limits for charts 1-200,000 and 1-400,000	1-15,000,000	Sketch	Engraved.
Co-tidal lines, Atlantic coast, &c	1-10,000,000	do	Do.
Winds of the western coast		Diagram	Do.
Diagram, difference of longitude between Savannah, Georgia, and Fernandina, Florida		do	Do.
Diagram illustrating loss of magnetism		do	Do.
Apparatus for measuring preliminary base lines		Sketch	Do.
Sands' specimen tube for deep-sea bottom; Massey's indicator, and Burt's sounding nipper		Diagram	Do.
Modification of Brook's sounding apparatus		do	Do.
Trenchard's and Mitchell's tide-gauges		do	Do.

° Engraved on stone, under the direction of the Superintendent of Public Printing.

List of Coast Survey maps, preliminary charts, and sketches engraved—geographically arranged.

1. List of Maps and Charts engraved.

No. 1.	Richmond island, Maine	$\frac{1}{20000}$
2.	Newburyport harbor, Massachusetts	$\frac{1}{20000}$
3.	Ipswich and Annis Squam harbors, Massachusetts	$\frac{1}{20000}$
4.	Gloucester harbor ... do	$\frac{1}{20000}$
5.	Salem harbor ... do	$\frac{1}{25000}$
6.	Boston harbor—new edition, 1857 ... do	$\frac{1}{40000}$
7.	Plymouth harbor ... do	$\frac{1}{20000}$
8.	Provincetown harbor ... do	$\frac{1}{50000}$
9.	Monomoy shoals ... do	$\frac{1}{40000}$
10.	Bass River harbor ... do	$\frac{1}{40000}$
11.	Wellfleet harbor ... do	$\frac{1}{60000}$
12.	Nantucket harbor ... do	$\frac{1}{20000}$
13.	Hyannis harbor ... do	$\frac{1}{30000}$
14.	Harbor of Edgartown ... do	$\frac{1}{20000}$
15.	Harbor of Wood's Hole ... do	$\frac{1}{20000}$
16.	Harbors of Holmes' Hole and Tarpaulin Cove, Massachusetts	$\frac{1}{20000}$
17.	Harbor of New Bedford, Massachusetts	$\frac{1}{40000}$
18.	General chart of coast from Gay Head to Cape Henlopen	$\frac{1}{400000}$
19.	Fisher's Island sound, Connecticut	$\frac{1}{40000}$
20.	Harbor of New London ... do	$\frac{1}{20000}$
21.	Mouth of Connecticut river ... do	$\frac{1}{20000}$
22.	Harbor of New Haven—new edition, 1852	$\frac{1}{30000}$
23.	Harbors of Black Rock and Bridgeport, Connecticut—new edition, 1852	$\frac{1}{20000}$
24.	Harbors of Sheffield and Cawkins island ... do ... do ... 1852	$\frac{1}{20000}$
25.	Huntington bay, New York	$\frac{1}{30000}$
26.	Oyster bay or Syosset harbor, New York	$\frac{1}{30000}$
27.	Harbors of Captain's islands, east and west, New York	$\frac{1}{20000}$
28.	Hart and City islands and Sachem's Head harbor, New York	$\frac{1}{10000}$, $\frac{1}{20000}$
29.	Hell Gate, New York	$\frac{1}{5000}$
30.	Long Island sound, east	$\frac{1}{80000}$
31.	Do ... do ... middle	$\frac{1}{80000}$
32.	Do ... do ... west	$\frac{1}{80000}$
33.	New York bay and harbor, and the environs, New York—sheet No. 1	$\frac{1}{30000}$
34.	Do ... do ... do ... do ... do ... No. 2	$\frac{1}{30000}$
35.	Do ... do ... do ... do ... do ... No. 3	$\frac{1}{30000}$
36.	Do ... do ... do ... do ... do ... No. 4	$\frac{1}{30000}$
37.	Do ... do ... do ... do ... do ... No. 5	$\frac{1}{30000}$
38.	Do ... do ... do ... do ... do ... No. 6	$\frac{1}{30000}$
39.	Do ... do ... do ... do ... do.	$\frac{1}{80000}$
40.	Western part of south coast of Long Island, New York	$\frac{1}{80000}$
41.	Middle part ... do ... do ... do	$\frac{1}{80000}$

42. Eastern part of south coast of Long Island, New York $\frac{1}{80000}$
43. Little Egg harbor, New Jersey $\frac{1}{30000}$
44. Delaware bay and river—sheet No. 1, Delaware $\frac{1}{80000}$
45. Do......do.......do..No. 2, New Jersey and Pennsylvania $\frac{1}{80000}$
46. Do......do.......do..No. 3 $\frac{1}{80000}$
47. Harbor of Annapolis and Severn river, Maryland $\frac{1}{60000}$
48. Mouth of Chester river, Maryland $\frac{1}{40000}$
49. York river, Virginia $\frac{1}{60000}$
50. Pasquotank river, North Carolina $\frac{1}{60000}$
51. Beaufort harbor......do. $\frac{1}{20000}$
52. Charleston harbor, South Carolina—new edition, 1856 $\frac{1}{30000}$
53. Key West harbor and its approaches, Florida $\frac{1}{50000}$
54. Entrance to Mobile bay, Alabama $\frac{1}{40000}$
55. Mobile bay, Alabama $\frac{1}{80000}$
56. Cat and Ship Islands harbors, Mississippi. $\frac{1}{40000}$
57. Entrance to Galveston bay, Texas—new edition, 1856 $\frac{1}{40000}$
58. San Diego bay, California $\frac{1}{40000}$

2. List of Preliminary Charts and Sketches engraved.

No. 1. Alden's Rock, Maine $\frac{1}{1000}$
2. Eggemoggin reach, Maine $\frac{1}{20000}$
3. Portland harbor.....do $\frac{1}{20000}$
4. Portland harbor, (Commissioners' line,) Maine $\frac{1}{10000}$
5. York river harbor..................do $\frac{1}{20000}$
6. Portsmouth harbor, New Hampshire $\frac{1}{20000}$
7. Stellwagen's Bank—2d edition, Massachusetts $\frac{1}{400000}$
8. Boston bay.......................do $\frac{1}{175000}$
9. Current chart, Boston harbor......do $\frac{1}{100000}$
10. Minot's ledge....................do $\frac{1}{10000}$
11. Seacoast of the United States No. 4, south part of Massachusetts $\frac{1}{200000}$
12. Nantucket shoals, Massachusetts—new edition $\frac{1}{200000}$
13. Tidal currents, Nantucket shoals, Massachusetts $\frac{1}{300000}$
14. Muskeget channel...................do $\frac{1}{60000}$
15. Sow and Pig's reef..................do $\frac{1}{240}$ & $\frac{1}{20000}$
16. Tidal currents, Long Island...........do $\frac{1}{800000}$
17. Pot Rock and Way's reef, New York
18. Hudson river, lower sheet.....do $\frac{1}{60000}$
19. Buttermilk channel..........do $\frac{1}{5000}$
20. Beacon ranges, New York harbor $\frac{1}{40000}$
21. Romer shoals and Flynn's knoll, New York $\frac{1}{40000}$
22. Changes in Sandy Hook, New Jersey $\frac{1}{10000}$ & $\frac{1}{40000}$
23. Seacoast of Delaware, Maryland, and part of Virginia $\frac{1}{200000}$
24. Delaware and Chesapeake bays $\frac{1}{400000}$
25. Chesapeake bay, (upper series,) sheet No. 1 $\frac{1}{80000}$
26. Do.............do.......do..No. 2 $\frac{1}{80000}$

27. Chesapeake bay, (upper series,) sheet No. 3 .... $\frac{1}{80000}$
28. Chincoteague inlet, Virginia .... $\frac{1}{40000}$
29. Seacoast of Virginia and entrance to Chesapeake bay, Virginia .... $\frac{1}{200000}$
30. James river, (upper sheet,) Virginia .... $\frac{1}{40000}$
31. Rappahannock river, No. 1, Virginia .... $\frac{1}{20000}$
32. Do .... No. 2 .... do .... $\frac{1}{20000}$
33. Do .... No. 3 .... do .... $\frac{1}{20000}$
34. Do .... No. 4 .... do .... $\frac{1}{20000}$
35. Do .... No. 5 .... do .... $\frac{1}{60000}$
36. Do .... No. 6 .... do .... $\frac{1}{60000}$
37. Wachapreague, Machipongo, and Metomkin inlets, Virginia .... $\frac{1}{40000}$
38. Ship and Sand Shoal inlets, Virginia .... $\frac{1}{40000}$
39. Entrance to Chesapeake bay ... do .... $\frac{1}{100000}$
40. Cape Charles and vicinity ..... do .... $\frac{1}{80000}$
41. Cherrystone inlet .... do .... $\frac{1}{40000}$
42. Pungoteague creek .... do .... $\frac{1}{40000}$
43. Fishing or Donoho's battery, Maryland .... $\frac{1}{80000}$
44. Albemarle sound, North Carolina .... $\frac{1}{200000}$
45. Diagrams showing the effect of the wind in elevating or depressing the water in Albemarle sound ....
46. Hatteras shoals, North Carolina .... $\frac{1}{20000}$
47. Cape Hatteras ...... do .... $\frac{1}{20000}$
48. Hatteras inlet .... do ...... fourth edition .... $\frac{1}{20000}$
49. Ocracoke inlet .... do .... $\frac{1}{40000}$
50. Seacoast, North Carolina, from Hatteras to Ocracoke .... $\frac{1}{200000}$
51. Wimble shoals, North Carolina .... $\frac{1}{80000}$
52. Beaufort harbor ...... do .... $\frac{1}{20000}$
53. New river and bar .... do .... $\frac{1}{15000}$
54. Frying-pan shoals ..... do .... $\frac{1}{120000}$
55. Cape Fear river and new inlet, North Carolina .... $\frac{1}{40000}$
56. Entrances to Cape Fear river, new edition, North Carolina .... $\frac{1}{30000}$
57. Cape Fear river, from Federal Point to Wilmington .... $\frac{1}{30000}$
58. Gulf Stream explorations, 1853 .... $\frac{1}{6000000}$
59. Diagrams, Gulf Stream explorations, 1853 ....
60. Gulf Stream explorations, 1854 .... $\frac{1}{5000000}$
61. Diagrams, Gulf Stream explorations, 1854 ....
62. Gulf Stream explorations, 1855 .... $\frac{1}{6000000}$
63. Co-tidal lines, Atlantic coast .... $\frac{1}{10000000}$ & $\frac{1}{15000000}$
64. Diagrams of secular variation of magnetic dip, Atlantic Coast ....
65. Cape Roman shoals, South Carolina .... $\frac{1}{100000}$
66. Seacoast of the United States, No. 14, South Carolina .... $\frac{1}{200000}$
67. Winyah bay and Cape Roman shoals .... do .... $\frac{1}{100000}$
68. Winyah bay and Georgetown harbor .... do .... $\frac{1}{40000}$
69. Bull's bay .... do .... $\frac{1}{40000}$
70. Comparative chart, Maffitt's channel, South Carolina—new edition .... $\frac{1}{5000}$

71.	Maffitt's channel, sections, South Carolina	
72.	North Edisto river, (new edition,) South Carolina	$\frac{1}{50000}$
73.	Romerly marshes ... do	$\frac{1}{10000}$
74.	Savannah river entrance, Georgia	$\frac{1}{30000}$
75.	Savannah city, Front and Back rivers, Georgia	$\frac{1}{20000}$
76.	Savannah river, Georgia	$\frac{1}{40000}$
77.	Doboy bar and inlet, Georgia	$\frac{1}{40000}$
78.	St. Simon's sound and Brunswick harbor, Georgia	$\frac{1}{40000}$
79.	St. Andrew's shoals, Georgia	$\frac{1}{60000}$
80.	St. Mary's bar and Fernandina harbor, Florida—comparative chart	$\frac{1}{20000}$
81.	St. Mary's river and Fernandina harbor, Florida	$\frac{1}{20000}$
82.	St. John's river from entrance to Brown's creek, Florida	$\frac{1}{25000}$
83.	Musquito inlet ... do	$\frac{1}{40000}$
84.	Cape Cañaveral ... do	$\frac{1}{60000}$
85.	Florida reefs ... do	$\frac{1}{200000}$
86.	Turtle harbor, Florida reefs ... do	$\frac{1}{40000}$
87.	Beacons on Florida reefs ... do	
88.	Coffin's Patches ... do	$\frac{1}{20000}$
89.	Key Biscayne, Cape Sable and bases ... do	$\frac{1}{400}$ & $\frac{1}{600000}$
90.	Legaré anchorage, (additions) ... do	$\frac{1}{20000}$
91.	Key West harbor, Florida, second edition	$\frac{1}{100000}$
92–98.	Key West tidal diagrams, Florida	
99.	Rebecca shoals ... do	$\frac{1}{600000}$
100.	Reconnaissance vicinity of Cedar Keys, Florida	$\frac{1}{300000}$
101.	Channel No. 4, Cedar Keys ... do	$\frac{1}{30000}$
102.	Cedar Keys and approaches ... do	$\frac{1}{50000}$
103.	Ocilla river ... do	$\frac{1}{20000}$
104.	St. Mark's bar and channel ... do	$\frac{1}{40000}$
105.	Middle, or main and western entrances, St. George's sound, Florida	$\frac{1}{80000}$
106.	St. Andrew's bay ... do	$\frac{1}{40000}$
107.	Entrance to Pensacola bay ... do	$\frac{1}{30000}$
108.	Seacoast of part of Alabama and Misssissippi	$\frac{1}{200000}$
109.	Mobile bay, second edition, Alabama	$\frac{1}{200000}$
110.	Horn Island pass and Grand bay, Mississippi	$\frac{1}{300000}$
111.	Do ... do ... do ... new edition	$\frac{1}{40000}$
112.	Pascagoula river ... do	$\frac{1}{20000}$
113.	Biloxi bay ... do	$\frac{1}{40000}$
114–123.	Cat Island tidal diagrams ... do	
124.	Pass Christian ... do	$\frac{1}{40000}$
125.	Delta of Mississippi, Louisiana	$\frac{1}{60000}$
126.	Gulf of Mexico, with profiles of deep-sea soundings—new edition	$\frac{1}{2400000}$
127.	Barataria bay entrance, Louisiana	$\frac{1}{30000}$
128.	Pass Fourchon ... do	$\frac{1}{10000}$
129.	Timballier bay entrance ... do	$\frac{1}{20000}$
130.	Isle Dernière, or Ship Island shoals	$\frac{1}{80000}$

131.	Entrances to Vermilion bay and Calcasieu river	$\frac{1}{80000}$ & $\frac{1}{40000}$
132.	Sabine pass, Texas	$\frac{1}{40000}$
133.	Seacoast of Texas from Galveston, south	$\frac{1}{200000}$
134.	Seacoast of the United States, No. 31, part of Texas	$\frac{1}{200000}$
135.	San Luis pass, Texas	$\frac{1}{20000}$
136.	Aransas pass—2d edition—Texas	$\frac{1}{30000}$
137.	Entrance to Rio Grande ....do	$\frac{1}{20000}$
138.	Diagrams of heights and lunitidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico	
129–140.	Co-tidal lines, Gulf of Mexico—2 plates	
141.	Type curves, Gulf of Mexico	
142.	Wind curves, Cat island	
143.	Alden's reconnaissance Western Coast, lower sheet, San Francisco to San Diego—new edition—California	$\frac{1}{1200000}$
144.	Cortez bank	$\frac{1}{10000}$, $\frac{1}{1200000}$
145.	San Diego entrance, (new edition,) California	$\frac{1}{15000}$, $\frac{1}{25000}$
146.	Geological map of San Diego, California	$\frac{1}{1608228}$
147.	Catalina harbor ....do	$\frac{1}{15000}$
148.	San Pedro anchorage and vicinity of Santa Barbara, California	$\frac{1}{20000}$, $\frac{1}{40000}$
149.	Anacapa island, (sketch) ....do	
150.	Anacapa island and east end of Santa Cruz island ....do	$\frac{1}{30000}$
151.	Prisoner's harbor, Cuyler's harbor, and northwest anchorage San Clemente island, California	$\frac{1}{20000}$
152.	Santa Barbara, California	$\frac{1}{20000}$
153.	Eastern entrance to Santa Barbara channel, California	$\frac{1}{80000}$
154.	San Simeon, Santa Cruz, San Luis Obispo, and Coxo harbors, California	$\frac{1}{20000}$, $\frac{1}{40000}$
155.	Point Conception ....do	$\frac{1}{40000}$
156.	Point Pinos ....do	$\frac{1}{20000}$
157.	Monterey harbor ....do	$\frac{1}{40000}$
158.	Monterey bay ....do	$\frac{1}{60000}$
159.	Geological map of Monterey ....do	$\frac{1}{150000}$
160.	Santa Cruz and Año Nuevo harbors ....do	$\frac{1}{40000}$, $\frac{1}{1200000}$
161.	San Pedro harbor ....do	$\frac{1}{20000}$
162.	San Francisco bay entrance ....do	$\frac{1}{400000}$
163.	San Francisco city—3d edition ....do	$\frac{1}{10000}$
164.	Geological map, San Francisco ....do	$\frac{1}{150000}$
165.	South Farallon island ....do	
166.	Tidal diagrams, Rincon Point ....do	
167.	Pulgas base ....do	$\frac{1}{40000}$, $\frac{1}{400000}$
168.	San Antonio creek ....do	$\frac{1}{20000}$
169.	Mare Island straits ....do	$\frac{1}{30000}$
170.	Alden's reconnaissance Western Coast, middle sheet, San Francisco to Umpquah river, California and Oregon	$\frac{1}{1200000}$
171.	McArthur's reconnaissance Western Coast from Monterey to mouth of Columbia river, sheet No. 1—3d edition	

172.	McArthur's reconnaissance Western Coast from Monterey to mouth of Columbia river, sheet No. 2—3d edition	
173.	McArthur's reconnaissance Western Coast from Monterey to mouth of Columbia river, sheet No. 3—3d edition	
174.	Alden's reconnaissance Western Coast, northern sheet	$\frac{1}{1200000}$
175.	Point Reyes and Drake's bay, California	$\frac{1}{40000}$
176.	Geological map Point Reyes, California	$\frac{1}{1500000}$
177.	Humboldt bay ... do	$\frac{1}{30000}$
178.	Trinidad bay ... do	$\frac{1}{20000}$
179.	Shelter cove, Mendocino city, and Crescent city harbors, and Port Orford or Ewing harbor, California and Oregon	$\frac{1}{20000}$
180.	Umpquah river, Oregon	$\frac{1}{20000}$
181.	Mouth of Columbia river—2d edition—Oregon	$\frac{1}{40000}$
182.	Do ... do	$\frac{1}{200000}$
183.	Entrance to Columbia river ... do	$\frac{1}{40000}$
184.	Tidal diagrams Rincon Point, San Diego, and Astoria, California and Oregon	
185.	Co-tidal lines of the Pacific Coast	$\frac{1}{1000000}$
186.	Cape Disappointment, Washington Territory	$\frac{1}{20000}$
187.	Shoalwater bay—new edition ... do	$\frac{1}{80000}$
188.	Alden's reconnaissance Western Coast, from Gray's harbor to Admiralty inlet, Washington Territory	$\frac{1}{600000}$
189.	Grenville harbor ... do	$\frac{1}{20000}$
190.	Cape Flattery and Née-ah harbor, Washington Territory	$\frac{1}{40000}$
191.	False Dungeness harbor ... do	$\frac{1}{30000}$
192.	New Dungeness harbor ... do	$\frac{1}{40000}$
193.	Canal de Haro and Strait of Rosario and approaches, Washington Territory	$\frac{1}{200000}$ & $\frac{1}{600000}$
194.	Port Townsend, Washington Territory	$\frac{1}{40000}$
195.	Duwamish bay and Seattle harbor, Washington Territory	$\frac{1}{40000}$
196.	Smith's or Blunt's island ... do	$\frac{1}{20000}$
197.	Port Ludlow ... do	$\frac{1}{20000}$
198.	Port Gamble ... do	$\frac{1}{20000}$
199.	Olympia harbor ... do	$\frac{1}{20000}$
200.	Steilacoom harbor ... do	$\frac{1}{30000}$
201.	Bellingham bay ... do	$\frac{1}{40000}$
202.	Blakely harbor ... do	$\frac{1}{10000}$
203.	Base apparatus	
204.	Self-registering tide-gauge	
205.	Craven's current indicator	
206.	Craven's specimen box for deep-sea soundings	
207.	Mitchell's seacoast tide-gauge	
208.	Figures to illustrate Appendix No. 33, 1854	
209.	Diagrams of secular variation in magnetic declination, 1855	
210.	Lines of equal magnetic declination	$\frac{1}{15000000}$

Report of Mr. George Mathiot, in charge of the Electrotype Division.

U. S. COAST SURVEY OFFICE,
October 1, 1858.

I respectfully present the following report of the operations in this division since October 1, 1857:

By the electrotype process we have made ninety-five plates. Of this number forty-six were in alto and forty-nine in basso. I append tables of the plates.

The work of combining, extending, and altering the engraved plates of the charts of the survey, by means of thin electrotypes, has proved of such great utility to the engraving division in reconstructing the charts, in saving the re-engraving of large portions of the work, and in facilitating the distribution of labor, that it now forms a prominent feature in the plans of that division. During the year I have applied the process to ten plates, the major portion of which belonged to the most important charts of the survey.

The work of this division has been greatly increased by making use of the electrotype, as a sort of insurance against the loss or destruction of the unfinished plates intended for the report while away from the office, in transportation or in the hands of the lithographer. An alto of an expensive plate will cost but a small fraction of one per cent. of the price of the plate; it has now become the practice to make an alto of a plate, for retention in the office, before subjecting it to the risk of transportation, and the consequent probability of the loss of time and expense for re-engraving it.

I have continued to prosecute my researches in the various processes of photography, with a view to the use of the photograph in the preparation of the drawings for the engravers. It is now certain the photograph will shortly come into extensive use in the office for the reduction of drawings to smaller scales. An application of this has been made in the reduction of San Pablo bay from a $\frac{1}{50000}$ to a $\frac{1}{80000}$ scale. There is also an encouraging prospect of success in the efforts economically to employ the art in the *construction* of the drawings directly from plane-table sheets. I have not the least doubt but that I should have been able to announce the success of these efforts in this report had I not been prevented from experimenting by want of suitable apartments for the purpose and a loss of nearly two months of my time by sickness. Complete arrangements, however, have been made for making use of photography. Apparatus and instruments of the most approved kind have been obtained or constructed, and an addition to the portico of the building is in course of erection; this, when finished, will enable me to prosecute my experiments more rapidly, and will doubtless lead to an advantageous use of photography in the survey.

List of plates electrotyped in alto.

Name of chart.	No. made.	Name of chart.	No. made.
Bellingham bay	2	South side of Long Island	1
Blakely harbor	1	Shoalwater bay	1
Boston harbor	2	St. Andrew's bay	2
Bass river	1	Seacoast of United States from South Carolina to	
Cape Fear river	1	Georgia	2
Changes in Sandy Hook	1	Chesapeake bay, sheet No. 6	1
Florida reefs	1	Chesapeake bay, sheet No. 5, (in two parts)	2
Gulf stream sketch	1	Chesapeake bay, sheet No. 4, (in two parts)	3
Harbor of Pass Christian	1	Long Island sound, sheet No. 2	1
Legaré anchorage	2	Long Island sound, sheet No. 3	1
Port Gamble	1	Reconnaissance of western coast, sheet No. 1,	
Port Ludlow	1	(Alden's)	2
Plymouth harbor	1	Reconnaissance of western coast, sheet No. 2,	
Rappahannock river	2	(Alden's)	1
Romerly marshes	1	Reconnaissance of western coast, sheet No. 3,	
San Diego bay	1	(Alden's)	1
Progress sketch, sec. 6	1	Southern coast of Long Island, sheet No. 2	1
Delaware and Chesapeake bays	1	Southern coast of Long Island, sheet No. 3	1
Seacoast of Alabama and Mississippi	2	Wachapreague } inlets, &c	1
Steilacoom harbor	1	Machipongo }	

List of plates electrotyped in basso.

Name of chart.	No. made.	Name of chart.	No. made.
Annapolis harbor	1	Plymouth harbor	1
Bellingham bay	1	Port Ludlow	1
Blakely harbor	1	Port Gamble	1
Black rock and Bridgeport	1	Rappahannock river	1
Boston harbor	2	Reconnaissance of western coast, (Alden's,) sheet No. 1	1
Cedar Keys	1	Reconnaissance of western coast, (Alden's,) sheet No. 2	2
Chesapeake bay, sheet No. 4	1	Reconnaissance of western coast, (Alden's,) sheet No. 3	1
Chesapeake bay, sheet No. 5	1	San Diego bay and approaches	1
Charleston harbor	1	Seacoast of Alabama and Mississippi	1
Delaware bay and river, sheet No. 1	1	Steilacoom harbor	1
Delaware bay and river, sheet No. 2	1	St. John's river, No. 1	1
Delaware bay and river, sheet No. 3	1	Seacoast of United States from South Carolina to Georgia	2
Delaware and Chesapeake bays	1	Seacoast of Virginia and entrance to Chesapeake bay	1
Entrance to Cape Fear river	1	Seacoast of part of Mississippi and Louisiana	1
Hyannis harbor	1	South side of Long Island, sheet No. 2	1
Harbor of Newburyport	1	South side of Long Island, sheet No. 3	1
Long Island sound, sheet No. 2	2	Progress sketch, section 6	1
Long Island sound, sheet No. 3	2	Changes in Sandy Hook	1
Legaré anchorage	1	Port Orford	1
Muskeget channel	1	Winyah bay and Georgetown harbor	1
Mouth of Connecticut river	1		
North Edisto	1		
Wachapreague / Machipongo } inlets, &c	1		
Monomoy shoals	1		

List of plates altered, extended, or reformed by the electrotype process.

NAME OF PLATE.	NAME OF PLATE.
Chesapeake bay, No. 4.	Legaré anchorage.
Chesapeake bay, No. 5.	Long Island sound, No. 3.
Seacoast of United States from South Carolina to Georgia.	Long Island sound, No. 1.
Seacoast of part of Mississippi and Louisiana.	Long Island sound, No. 2.
Progress sketch, section 6, $\frac{1}{200000}$.	Middle part of Long Island sound, No. 2.

Report of Lieut. James P. Roy, U. S. A., in charge of the Miscellaneous Division.

COAST SURVEY OFFICE,
Washington, October 1, 1858.

The Miscellaneous Division, comprising the map room, distribution of maps and charts and Coast Survey Reports, and the printing, has been organized since the date of the last report and been placed under my charge.

Mr. V. E. King, assisted by Mr. Holden, has had the general superintendence of the map room, distribution of Coast Survey maps, charts, and sketches, and reports of the Coast

Survey, and they have performed their duties in a very faithful and commendable manner. When not so employed Mr. King has performed clerical duties in the office of the assistant in charge, where his services have been highly valuable.

Mr. John Rutherdale, as printer, has, as heretofore, been attentive and zealous in the discharge of his duties.

Hereunto appended is a statement of Coast Survey maps, charts, and sketches, and reports of the Coast Survey distributed, and also the maps, charts, and sketches, printed during the year.

List of Coast Survey maps, charts, and sketches distributed during the year, for sale, use of office, and gratuitously.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Richmond's Island harbor	2	1	22	25
York River harbor	2		25	27
Newburyport harbor	2		31	33
Gloucester harbor	2		30	32
Salem harbor	7	3	37	47
Wellfleet harbor	2		27	29
Boston harbor	132	18	601	751
Nantucket harbor	8		23	31
Edgartown harbor	5			5
Hyannis harbor	8		27	35
Harbors of Holmes' Hole and Tarpaulin cove	3	1	26	30
Harbor of New Bedford	83		49	132
General coast chart from Gay head to Cape Henlopen	5	6	61	72
Long Island sound	43	3	3	49
Fisher's Island sound	13		30	43
Harbor of New London	28	1	32	61
Mouth of Connecticut river	3		27	30
Harbor of New Haven	13	2	30	45
Harbors of Black rock and Bridgeport	8		27	35
Huntington bay	13		27	40
Harbors of Sheffield and Cawkin's island	7		26	33
Harbors of Captain's island, east and west			2	2
Oyster bay or Syosset harbor	12		27	39
Hart and City islands and Sachem's head harbor	7		28	35
Hell Gate	22	2	37	61
New York bay and harbor and the environs, $\frac{1}{30000}$	25		5	30
New York bay and harbor and the environs, $\frac{1}{80000}$	122	18	61	201
Western part of south coast of Long Island	2	2	26	30
Eastern part of south coast of Long Island			5	5
Little Egg harbor	2	1	24	27
Delaware bay and river	58	7	44	109
Mouth of Chester river	2	2	25	29
Harbor of Annapolis and Severn river	2	4	26	32
Pasquotank river	2	2	25	29

List of Coast Survey maps distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Beaufort harbor	5		4	9
Charleston harbor	12	4	47	63
Cat and Ship Island harbors	2	1	26	29
Mobile bay	27	6	55	88
Mobile bay entrance	12		36	48
Galveston entrance	12		45	57
Key West harbor and approaches	12	5	54	71
West coast reconnaissance, from San Diego to San Francisco	104	5	39	148
West coast reconnaissance, from San Francisco to Umpquah river	104	5	43	152
West coast reconnaissance, from Umpquah river to the NW. boundary	104	4	32	140
San Diego bay and approaches	18		27	45
Trinidad bay	13		25	38
Humboldt bay	12		40	52
Monterey harbor	13		26	39
Entrance to Columbia river	13		47	60
Sketches of—Minot's ledge	2		45	47
Plymouth harbor		3	24	27
Muskeget channel	2	1	30	33
Monomoy shoals		3	5	8
Nantucket shoals	13	1	40	54
Delaware and Chesapeake bays	50	11	50	111
Seacoast of Delaware, Maryland, and part of Virginia	14	2	16	32
Chincoteague inlet	2	1	9	12
Seacoast of Virginia and entrance to Chesapeake bay	10	2	5	17
Albemarle Sound	10		2	12
Ocracoke inlet	7	2	9	18
Frying-Pan shoals	7		31	38
New river and bar	2	1	28	31
Cape Fear river and New inlet	7	1	33	41
North Edisto entrance		1	24	25
Winyah bay and Georgetown harbor	7	2	49	58
Entrance to Savannah river	7	1	10	18
Savannah city, Front and Back rivers	2		20	22
Romerly marshes	2	1	35	38
St. Mark's bar and channel	2	1	12	15
St. John's river, from entrance to Brown's creek	7		18	25
Legaré anchorage	2		36	38
Cedar keys	2		13	15
St. Andrew's bay	4		35	39
Seacoast of Alabama and Mississippi	2	1	12	15
Biloxi bay	2	4	28	34
Delta of Mississippi river	1		23	24
Ship Island shoal	1		21	22
Galveston bay				
San Luis pass	1		30	31
Catalina harbor			3	3
Prisoner's, Cuyler's, and San Clemente harbors	11		11	22

List of Coast Survey maps distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Santa Barbara	11		11	22
Anacapa island	11		14	25
San Simeon, Santa Cruz, &c	11		29	40
Santa Cruz and Año Nuevo	11		27	38
San Pedro harbor	12	1	30	43
San Francisco city				
Port Orford, Shelter cove, &c	12		10	22
Entrance to Umpquah river	11		28	39
Shoalwater bay	11		10	21
Reconnaissance from Gray's harbor to Admiralty inlet	12		13	25
Cape Flattery and Neé-ah harbor	11		13	24
False Dungeness harbor	11	1	13	25
Port Townshend	11	2	14	27
Canal de Haro	36		49	85
Port Ludlow	11		29	40
Port Gamble	10	1	29	40
Blakely harbor	7		24	31
Bellingham bay	3	1	30	34
Steilacoom harbor	3	1	30	34
Eggemoggin reach	11		12	23
Current chart, Boston harbor	6		11	17
Stellwagen's bank	6		29	35
Sow and Pig's reef	6		30	36
Romer shoal and Flynn's knoll	6		29	35
Changes in Sandy Hook	6		40	46
Wachapreague and Machipongo inlets, &c	1		22	23
Ship and Sand Shoal inlets	1		22	23
Cherrystone inlet	1	1	10	12
Pungoteague creek	1	1	11	13
Fishing or Donoho's battery	1		9	10
Hatteras shoals	10	2	25	37
Hatteras inlet	11	2	42	55
Wimble shoals	1		42	43
Winyah bay and Cape Roman shoals	1	1	32	34
Bull's bay	1	1	27	29
Doboy bar and inlet	1		30	31
St. Andrew's shoals			17	17
Mosquito inlet	1		9	10
Cape Cañaveral	1		9	10
Rebecca shoal	1	1	9	11
Turtle harbor	1	1	11	13
Coffin's patches	6		11	17
Ocilla river	1		32	33
Entrance to St. George's sound	1		12	13
Horn Island pass	1		31	32
Entrance to Pascagoula river	1		21	22
Pass Christian			2	2

List of Coast Survey maps distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Entrance to Barataria bay	1	----------	41	42
Pass Fourchon	1	----------	28	29
Entrance to Timballier bay	1	----------	41	42
Vermilion bay	1	----------	41	42
Aransas pass	1	----------	6	7
Sabine pass	1	----------	9	10
Entrance to Rio Grande river	6	----------	29	35
San Pedro anchorage	16	----------	12	28
Mare Island straits	16	----------	11	27
Point Conception	16	----------	12	28
Point Pinos	16	----------	11	27
Point Reyes	16	----------	34	50
Cape Hancock	16	----------	11	27
Grenville harbor	16	----------	13	29
Duwamish bay and Seattle harbor	16	----------	12	28
Total	1,717	159	4,050	5,926

Distribution made during the year of the reports of the United States Coast Survey for the years 1851, 1852, 1853, 1854, 1855, *and* 1856.

Names of States, &c.	Report of 1851.			Report of 1852.			Report of 1853.			Report of 1854.			Report of 1855.			Report of 1856.		
	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.
Maine				2		2	2		2	2		2	27		27	101	8	109
New Hampshire					1	1	3	1	4	4	1	5	21	1	22	78	6	84
Vermont													10		10	63	2	65
Massachusetts	1		1	1		1	5		5	6		6	51		51	396	31	427
Rhode Island										1		1	15		15	50	3	53
Connecticut													30		30	129	13	142
New York	3		3	4		4	14		14	19		19	67		67	701	68	769
New Jersey				1		1	1		1	1		1	22		22	121	14	135
Pennsylvania	2		2	7		7	6		6	13		13	62		62	449	76	525
Delaware													12		12	15	2	17
Maryland	2		2	2		2	5		5	9		9	30		30	153	4	157
District of Columbia	4		4	4		4	11		11	11		11	25		25	128		128
Virginia	2		2	2		2	4		4	5		5	38		38	174	2	176
North Carolina							1		1				16		16	84	3	87
South Carolina													21		21	158	6	164
Georgia							1		1	1		1	24		24	87	1	88
Alabama													21		21	69	4	73
Mississippi													12		12	42	1	43
Louisiana	3		3	3		3	3		3	3		3	28		28	68	4	72
Ohio				1		1				1		1	22		22	253	32	285
Kentucky													13		13	90	13	103
Tennessee													11		11	79	15	94
Indiana													6		6	121	15	136
Illinois	1		1	1		1	2		2	2		2	18		18	118	27	145
Missouri	1		1	1		1	1		1	1		1	10		10	79	12	91
Arkansas																12		12
Michigan													19		19	59	13	72
Florida	1		1	1		1	1		1	1		1	21		21	41	1	42
Texas													14		14	45		45
Iowa													5		5	32	12	44
Wisconsin													15		15	68	4	72
California										1		1	17	5	22	64	2	66
Minnesota													1		1	12	2	14
Washington Territory				1		1	2		2	2		2	2		2	3		3
Kansas Territory										1		1	1		1	4		4
Nebraska Territory										1		1	1		1	4		4
Territory of New Mexico													1		1	1		1
Oregon Territory																1	1	2
Coast Survey Office and assistants	4		4	6		6	7		7	7		7	17		17	164		164
Members of Congress	1		1	6		6	14		14	14		14	306		306	33		33
Executive departments																99		99
Officers of the army																317		317
Officers of the navy																64		64
Receivers and registers of Land Office																166		166
Surveyors general of public lands																12		12
Inspectors of steamboats																9		9
Governors, State librarians, &c																163		163
Collectors of Customs																129		129
Captains in revenue service																24		24
Newspapers																96		96
Foreign	4		4	4		4	9		9	10		10	11		11	507	347	854
Grand total 8,035	29		29	47	1	48	92	1	93	116	1	117	1,063	6	1,069	5,935	744	6,679

Statement of Coast Survey maps, charts, and sketches, printed during the year.

SECTION I.

	No. of impressions.
Sketch A	35
Sketch A *bis*	35
Newburyport harbor	51
Boston harbor	825
Minot's Ledge	80
Plymouth harbor	413
Monomoy shoals	200
Nantucket shoals	12
Edgartown harbor	5
Wood's Hole	42
New Bedford harbor	50

SECTION II.

Eastern sheet of Long Island sound	372
Middle sheet of Long Island sound	375
Western sheet of Long Island sound	75
Eastern sheet of southern coast of Long Island	154
Middle sheet of southern coast of Long Island	25
Western sheet of southern coast of Long Island	65
Harbor of New London	100
Mouth of Connecticut river	100
Harbor of New Haven	70
New York bay and harbor and the environs, $\frac{1}{30000}$	320
New York bay and harbor and the environs, $\frac{1}{80000}$	127
Changes in Sandy Hook	175
Hudson river Δ^n	40

SECTION III.

Sketch C	35
Delaware bay and river, No. 1	296
Delaware bay and river, No. 2	275
Delaware bay and river, No. 3	270
Annapolis harbor and Severn river	337
Delaware and Chesapeake bays	100
Seacoast of Delaware, Maryland, and part of Virginia	50
Seacoast of Virginia and entrance to Chesapeake bay	115
Cape Charles	20
Ship and Sand Shoal inlets	25

SECTION IV.

Sketch D	35
Albemarle sound	112

	No. of impressions.
Beaufort harbor	100
Cape Fear river	22
SECTION V.	
Sketch E	40
Georgetown harbor	12
Sketch from Bull's bay to St. Helena sound	30
Sketch from Ossabaw island to Cumberland island	30
Charleston harbor	412
St. Andrew's shoals	100
SECTION VI.	
Sketch F	70
St. John's river	150
Florida reefs	100
Cedar Keys	200
SECTION VII.	
Sketch G	40
St. Andrew's bay	150
SECTION VIII.	
Sketch H	40
Mobile bay	153
Seacoast of Alabama and Mississippi	201
Cat and Ship Island harbors	50
Grand bay	15
SECTION IX.	
Sketch I	35
SECTION X.	
Sketch J, (lower sheet)	35
Sketch J, (middle sheet)	35
Alden's reconnaissance, No. 1	195
Alden's reconnaissance, No. 2	95
East entrance, Santa Barbara	30
San Simeon, Santa Cruz, &c	100
Humboldt bay	66
SECTION XI.	
Sketch K	35
Port Ludlow	150
Port Gamble	150

	No. of impressions.
Blakely harbor	200
Bellingham bay	150
Steilacoom harbor	250
Port Orford harbor	200

MISCELLANEOUS.

Proofs from finished and unfinished plates	2,055
Circular protractors	390
Pleiades for occultations	113
Scale of lettering	30
Diagram of winds, Western Coast	30
Diagram of loss of magnetism	30
Isogonic lines, Pacific ocean	75
Tide-gauge	55
Contact slide apparatus	30
Sketch showing the arrangement of general coast charts, $\frac{1}{400000}$, and preliminary charts, $\frac{1}{200000}$	40
Total	11,905

APPENDIX No. 20.

On a supposed personal equation in the use of the zenith telescope for determining latitudes by Talcott's method, by A. D. Bache, Superintendent United States Coast Survey.

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

The use of the zenith telescope to determine latitudes for the Coast Survey by Talcott's method has been explained in a paper read before the Association at the Cincinnati meeting in 1851. The difference of zenith distance of two stars passing the meridian nearly at the same time, one north and the other south of the zenith, and at nearly the same distance from the zenith, is measured by a micrometer. The sum of the same distances is given by the star catalogue, whence the zenith distance of each star of the pair becomes known, and from its declination the latitude of the place.

Observations at Mount Sebattis station, in Maine, in 1853, seemed to show that this method was not free from personal equation, either of observer or instrument. The same 23 pairs of stars observed with zenith telescopes No. 1 by Assistant J. E. Hilgard, and No. 2 by Sub-Assistant J. G. Oltmanns, gave results differing by $1''.12$, the probable accidental error of one value of the difference being $\pm\ 0''.77$, and that of the mean $\pm\ 0''.16$.

The probable accidental error of one observation was $\pm\ ''.81$ with the first, and $\pm\ 1''.14$ with the second observer; hence, for the mean of each pair, with an average number of three observations on each, the probable errors would be $\pm\ 0''.48$ and $\pm\ 0''.66$, respectively, and for the difference of two such means $\pm\ 0''.81$, scarcely differing from the value above stated, which is derived from a comparison of the differences among themselves.

The residual difference of 1''.12 appears, therefore, in the light of a constant quantity, and there being, thus, cause to suspect that identical results might not be obtained by two observers or by two different instruments, a plan of observation was laid out for settling the question.

At the telegraph station, Columbia, S. C., in 1854, Assistants B. A. Gould, jr., and G. W. Dean observed with zenith telescopes No. 2 and No. 5. The latitude found by Mr. Dean with both instruments was almost identically the same, being with No. 2, 33° 59′ 58″.14, and with No. 5, 33° 59′ 58″.10, with probable errors from twenty-one pairs of stars with the two instruments, respectively, of ± 0″.14 and ± 0″.16. With the same instruments and from the same stars Dr. Gould obtained 33° 59′ 58″.30 ± 0″.18 and 33° 59′ 58″.13 ± 0″.18.

The inquiry was continued at Ragged Mount station, Maine, in 1854, by Assistant G. W. Dean and Sub-Assistant Stephen Harris, under my direction, using the same instruments and observing the same pairs of stars. The resulting latitude, from observations on thirty-two pairs of stars, was absolutely identical, with a probable error of ± 0″.11 for the result by either observer.

A further trial with zenith telescopes No. 10 and No. 2 at Mount Harris station, Maine, by Assistant Dean and Sub-Assistant Goodfellow, under my direction, in which Mr. Dean used both instruments and Mr. Goodfellow No. 10, gives latitudes differing very slightly. Mr. Dean obtained, using zenith telescope No. 10, 44° 39′ 54″.49, and by No. 2, 54″.76, while Mr. Goodfellow, using No. 10, obtained 54″.83. The corresponding probable errors of the mean latitudes from thirty-three pairs of stars were ± 0″.14, 0″.13, and 0″.13.

Finally, at Mount Desert station, Maine, a comparison was made by Sub-Assistants Edward Goodfellow and Stephen Harris, using zenith telescope No. 5, and observing the same pairs of stars. The latitudes obtained from observations on thirty pairs of stars differed but two-hundredths of a second, with probable errors of ± 0″.13 and ± 0″.14.

The investigation has thus clearly proved that there is no personal equation of observer or instrument in the use of the zenith telescope by Talcott's method, but that identical results can be obtained by different observers with the same or different instruments, using the same pairs of stars for observing.

The accuracy of the final result, therefore, depends upon the accuracy of the declinations of the pairs of stars, upon the use of the proper number of pairs, and upon the care taken in determining the values of the micrometer and level divisions, and in using the instrument.

A probable error in observing of from ± 0″.25 to ± 1″.14 may be expected for one observation, according to the size and quality of the instrument and the ability of the observer. The probable error of the result by a single pair of stars as depending on the catalogue errors of the stars places, will range from ± 0″.60 to ± 1″.00, which will give from ± 0″.11 to ± 0″.18 for the latitude as resulting from thirty pairs.

The discrepancy in the results obtained at Sebattis may possibly be owing to some warping of the thin ledge of rock on which the instruments were mounted. The unusually large value of the accidental error of observation seems to indicate some disturbing influence.

The following table contains a recapitulation of these results. The first column gives the name of the station at which the observations were made; second, the date; third, the instrument; fourth, the observer's name; fifth, the number of pairs observed; sixth, the resulting latitude; seventh, the probable error of the result; eighth, the probable error of the result by a single pair of stars, derived from a comparison of the mean latitude with the result by each pair; and the ninth, the probable accidental error of one observation, derived from a comparison of the individual results for each pair of stars with their respective means.

Table showing results of observations for personal equation in determining latitudes by Talcott's method.

Station.	Date.	Zenith telescope.	Observer.	No. of pairs of stars.	Latitude.			Probable error of resulting latitude.	Probable error of result by single pair.	Probable accidental error of one observation.
					°	′	″			
Mount Sebattis	June, 1853	No. 1	J. E. Hilgard	23	44	08	37.82	± 0.16	± 0.90	± 0.81
		2	J. G. Oltmanns	23			38.94	0.22	1.08	1.14
Columbia	Feb., 1854	No. 2	G. W. Dean	21	33	59	58.14	0.14	0.62	0.86
		5	do	21			58.10	0.16	0.75	0.25
		2	B. A. Gould, jr.	21			58.30	0.18	0.83	0.56
		5	do	21			58.13	0.18	0.83	0.52
Ragged Mount	Oct., 1854	No. 5	G. W. Dean	32	44	12	42.79	0.11	0.62	0.25
		5	Stephen Harris	32			42.79	0.11	0.65	0.47
Mount Harris	Aug., 1855	No. 10	G. W. Dean	33	44	39	54.59	0.14	0.79	0.29
		2	do	33			54.76	0.13	0.73	0.37
		10	E. Goodfellow	33			54.83	0.13	0.74	0.44
Mount Desert	Aug., 1856	No. 5	E. Goodfellow	30	44	21	06.37	0.13	0.71	0.41
		5	S. Harris	30			06.39	0.14	0.76	0.46

APPENDIX No. 21.

Method of computing longitude from moon culminations.

The method of computing longitude from moon culminations, developed by the late SEARS C. WALKER, and published in detail in TRANS. AM. PHIL. SOC., new series, vol. V, is that which has heretofore been generally used in the Coast Survey. It consists, essentially, in comparing the increase of right ascension of the moon's bright limb, computed for an assumed longitude by interpolation with fourth differences, from the tabular right ascensions in the list of moon culminations with the observed increase, and deducing a correction to the assumed longitude from the residual. The tabular places are thus only used for computing the moon's motion, and the longitude depends mainly on *corresponding observations.*

Until a few years such was doubtless the only use that could safely be made of existing tables; but more recently the lunar ephemeris, in the American Nautical Almanac, affords places so nearly correct that they may safely be used in the place of corresponding observations where such have not been obtained. The Greenwich Nautical Almanac, now that Hansen's new tables of the moon have been published, will doubtless soon give likewise a corrected ephemeris. In all cases where a series of moon culminations have been observed, it will be advisable to collate the Greenwich observations, during the same period, with the tables for the purpose, deducing any corrections which may appear indicated.

The method given below for computing the longitude of a place from an observed transit of the moon's bright limb over the meridian has been given by Prof. PEIRCE. According to it, the right ascension of the moon's centre at the time of observation is computed from the observed right ascension of the bright limb, and the corresponding Greenwich mean time is found by interpolation from the hourly ephemeris of the moon. The corresponding Greenwich sidereal time, compared with the observed sidereal time, gives at once the longitude.

The following rules, illustrated by examples, embrace the whole process:

1. Obtain the best AR. of the moon's bright limb by comparison with the stars, (according to Form No. 1,) which will also be the sidereal time of observation.

2. To find the AR. of the moon's centre, add or subtract (for 1st or 2d limb) the moon's semi-diameter in time, multiplied by the secant of the declination, which interval must not be mistaken for the sidereal of the semi-diameter's passage over the meridian.

3. Take the difference between the AR. so obtained and that corresponding to the next preceding full hour of Greenwich mean time, from the ephemeris, and divide by the difference of AR. for 1^m, interpolated for the middle epoch; the quotient will be the mean time elapsed since the full hour.

4. To the mean time so obtained find the corresponding Greenwich sidereal time, the difference between which and the sidereal time found as in (1) will be the required longitude.

5. In order to find the moon's declination for the time of observation, and to interpolate the change in AR. during 1^m for the middle between the time of observation and the next preceding mean hour of Greenwich mean time, it is necessary to find approximately the Greenwich mean time of observation, for which an approximate longitude must be assumed. Form No. 2 shows the whole computation in detail.

Notes on observations of moon culminations.

In addition to the transits of moon and moon culminating stars, several stars ought to be observed suitably situated for determining instrumental corrections. It is desirable to keep the instrument very nearly in adjustment, so as to have the corrections small, since, if at all considerable, it is necessary to allow for the moon's motion in AR. and change of parallax.

When the moon's transit is not observed on all the wires the factor of the equatorial interval will be

$$\text{Sec. moon's geocentric dec.} \times \frac{60 + v}{60} \times \frac{\text{Sin. moon's geocentric Zen. Dist.}}{\text{Sin. moon's apparent Zen. Dist.}}$$

for which we may substitute,

$$\text{Sec. geoc. dec.} \times \frac{60 + v}{60} \times (1 - p \sin. 1'' \cos. \text{geoc. Zen. Dist.})$$

v being the change in AR. for 1^m, taken from the hourly ephemeris and expressed in seconds of time, and p the horizontal parallax expressed in seconds of arc.

For the corrections for level, collimation, or deviation, the sec. D in the factors requires to be multiplied by the same coefficients; but when they do not exceed 1^s it will be sufficiently near to increase each correction by its thirtieth part.

FORM No. 1.

UNITED STATES COAST SURVEY.

Station Restoration, September 11, 1856, *latitude* 47° 35′.

Name.	Observed transit of moon and stars.			Difference, moon — star.			Tab. AR. of star.			Deduced AR. of moon.		
	h.	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*	*h.*	*m.*	*s.*
α^2 Capricorni	18	56	59.51	+ 1	12	53.56	20	10	06.65	21	23	00.21
ψ Capricorni	19	24	29.98	+ 0	45	23.09	20	37	37.18			00.27
ω Capricorni	19	30	09.27	+ 0	39	43.80	20	43	16.70			00.50
1881 G. T. Y. C	19	43	08.34	+ 0	26	44.73	20	56	15.51			00.24
Moon I	20	09	53.07									
1913 G. T. Y. C	20	13	41.62	— 0	03	48.55	21	26	49.09			00.54
δ Capricorni	20	26	01.35	— 0	16	08.28	21	39	08.62			00.34
1952 G. T. Y. C	20	32	22.49	— 0	22	29.42	21	45	29.74			00.32
Mean										21	23	00.35

FORM No. 2.

UNITED STATES COAST SURVEY.

Station Restoration, September 11, 1856, *moon I.*

	h.	*m.*			
Observed sid. time	21	23		° ′	
Approx. long	8	10	Moon's dec. at 18*h*	— 19 59.2	
Greenwich sid. time	29	33	(*a*) 0.′22 × 7	+ 1.5	
Sid. time at mean noon	11	23	Moon's dec	— 19 57.7	Log. sec. 0.02691
Sid. interval	18	10	Moon's semi-diameter at 18*h*. 12*m* (*b*)	65*s*.40	Log. 1.81558
Green. mean time	18	07	Sid. interval of semi-diameter	69*s*.58	Log. 1.84249
	18.12				

FORM No. 2.—*Station Reservation*—Continued.

Diff AR. for 1*m*.	*s.*
Diff. 18*h*. to 19*h*	0.0037
f (*c*)	0.12
$\frac{\text{Diff.} \times f}{2}$	0.0002
Diff. AR. at 18*h*	2.4035
Diff. AR. for mid. epoch	2.4033

	h.	*m.*	*s.*		*h.*	*m.*	*s.*
Sid. time of transit of moon I	21	23	00.35				
Sid. interval of semi-diameter	+	1	09.58				
AR. of moon's centre	21	24	09.93				
Do.....do......September 11, at 18*h*	21	23	52.73				
			17.20	Log	1.23553		
Diff. of AR. for 1*m*	2*s*.4033			Colog	9.61920		
	60.			Log	1.77815		
Mean time interval after 18*h*			429.42	Log	2.63288		
Greenwich mean time of moon's arriving at observed AR.	18	07	09.42		18	02	57.42
						07	01.15
							09.02
Sid. interval	18	10	08.01				.42
Sid. time at mean noon	11	22	45.50				
Greenwich sid. time	29	32	53.51				
Observed sid. time	21	23	00.35				
Longitude W. from Greenwich	8	09	53.16				

(*a*) The change in declination for 1*m*. is 12.″94 = 0.′22.

(*b*) The moon's semi-diameter for 18*h*. 07*m*. is 16′ 20.″97 = 65*s*.40.

(*c*) f is the fractional part of one hour after the preceding full hour of Greenwich mean time.

APPENDIX No. 22.

Report of W. C. Bond, Esq., Director of Harvard Observatory, on the astronomical observations made for the Coast Survey since November 1, 1857.

CAMBRIDGE, *October* 26, 1858.

DEAR SIR: I have to report that thirteen hundred and fifty-one meridian star transits, ninety-seven moon culminations for longitude, seventeen observations of Polaris for intervals of wires, and seven sets of prime vertical observations for latitude have been made at this station since my last report, together with ninety individual observations of occultations of stars by the moon, and the termination of one solar eclipse, by four observers.

I have, as you requested, given special attention to the occultations of the stars in the group Pleiades.

Yours, respectfully,

W. C. BOND.

Prof. A. D. BACHE,

Superintendent U. S. Coast Survey.

APPENDIX No. 23.

Report of Professor O. M. Mitchel, Director of the Cincinnati Observatory, stating the number of astronomical observations made there for the use of the United States Coast Survey.

CINCINNATI OBSERVATORY, *October* 23, 1858.

DEAR SIR: The report of Mr. Henry Twitchell, Assistant in the Cincinnati Observatory, will present all requisite information on the subject of moon culminations which have been observed at the Cincinnati Observatory during the year.

No occultations have been observed, as the equatorial has been fixed on the meridian, devoted to experimental work in combination with the "new declinometer."

You will find, by an examination of the observations as reported from month to month, that their value has been greatly diminished by the effect of the city smoke, which, in certain directions of the wind, is driven over the observatory in heavy clouds.

We expect to remedy this growing evil during the coming year by a change in the location of the observatory.

We have closed all experimental work with the "declinometer." The observations of 1856 were made with this new instrument attached to the equatorial. Those of 1857 were made by employing the same instrument with the old Troughton transit, the property of the United States Coast Survey. In 1858 we again employed the equatorial, and have, in the three years, swept the same zone, and have, thus, observations for three successive years on the same stars. These agree with each other in a remarkable manner, and thus demonstrate the accuracy and reliability of this new instrument.

We hope to erect a large "transit instrument" in our new location during the coming year. This will relieve the equatorial from its temporary use as a transit, and will return it to its legitimate use as an extra meridional instrument.

Yours, respectfully,

O. M. MITCHEL,
Director Cincinnati Observatory.

Professor A. D. BACHE,
Superintendent United States Coast Survey.

CINCINNATI OBSERVATORY, *October* 23, 1858.

DEAR SIR: During the year 1858 and up to date fifty-six moon culminations, with the requisite number of star transits, have been observed at this station; of which forty-four have been reported. The May lunation (six culminations) was observed on occulting bars, and rejected. In the August lunation there were only two nights in which the moon could be observed, and the weather was so bad that the observations were rejected. In October four culminations have been observed, and not yet reported. The number of wires observed at each transit is fifteen in three tallies. The intervals between the wires in each tally are about three seconds of time at the equator, and the intervals between the tallies seventeen seconds nearly.

The records are made with an electro-magnet upon the "time-disc;" a make-circuit is used, and the records are punctures made in the paper disc by a steel point. The observation pen is distinct from the time pen, and driven by a separate battery. The observations are measured by a circular micrometer, reading the hundredths of seconds.

Yours, respectfully,

H. TWITCHELL,
Assistant Cincinnati Observatory.

Professor O. M. MITCHEL.

APPENDIX No. 24.

Continuation of the list of magnetic stations and results given in Appendix No. 28, *Coast Survey Report of* 1856.

Number.	Name of station.	Latitude.	Longitude.	Declination—west.	Dip.	Horizontal intensity.	Date.	Locality, geology, and remarks.
		° '	° '	° '	° '			
158	Humpback Mountain...	44 51.8	68 06.2	15 47.8	76 12.0	3.224	1858. Aug. 24; Sept. 15.	At the summit of the mountain, 46½ metres in a northerly direction from the geodetic station. The geological formation appears to be chiefly granite, intersected by trap dykes.
159	Calais.................	45 11.2	67 16.8	15 21.1	76 23.7	3.218	1857. Sept. 16—23. ...	About 400 feet south of the astronomical station. There are several ledges of granite and hornblende not far distant; also many surface rocks of the same material. No local attraction is suspected. Dip observed near powder-house, Calais, 76° 27'.3.
160	Mount Desert..........	44 21.1	68 13.2	15 14.2	76 09.2	3.251	1856. Oct. 7—13.......	On the summit of Mount Desert, about 115 metres from geodetic station towards station Humpback. The geological formation is red sienite, intersected with veins of quartz and occasional trap dykes of green stone. Iron ore has been found in several localities upon the slopes of hills, but none was discovered near the magnetic station.
161	Southwest Harbor	....	....	15 25.2	76 15.5	3.277	Sept. 25—30.....	Mount Desert islands, in the southern end of the village of S. W. Harbor, in a field about 250 yards SE. of Mr. Joseph Moore's barn. The geological formation is red sienite.
162	Mount Saunders.......	44 39.0	68 36.2	14 59.4	75 58.6	3.265	July 8—17.......	Half a mile distant from geodetic station, bearing from it S. 28° W. The soil is a light sand, overlying felspathic granite; surrounding hills felspathic granite, and generally bare.
163	Thomas' Hill, Bangor..	44 48.1	68 46.6	15 19.9	76 12.9	3.223	1857. Oct. 10—16......	Six hundred feet distant from geodetic station, in range with Mount Waldo. The geological formation is argillaceous slate; apparently no indications of local attraction.
164	Dudley Observatory, Albany.	42 39.8	73 42.7	8 17.0	74 55.6	3.574	1858. May 12—19......	Two hundred and nine feet due south from centre of transit instrument. The soil in the immediate vicinity appears to be clay, covered with a rich black loam to the depth of 8 or 10 inches. No indications of local magnetic disturbance.
101(*b*)*	Fort McHenry, Baltimore.	39 15.9	76 34.8	2 29.3	71 45.8	4.203	1856. Sept. 13.........	Near the infirmary, outside the fort, and in an open field, 445 metres west, and 227 metres north, of the flagstaff. The soil consists of clay and marl, mixed with pebbles.
165	United States Coast Survey Office, Washington, D. C.	38 53.1	77 00.2	2 21.7	71 21.7 71 22.6	4.308	Aug. 4; Sept. 24. 1858. June 2...........	Station in an open lot, adjoining the yard of No. 577 New Jersey avenue, on the slope of Capitol hill. Distance to nearest corner of building, 65 feet; it bears from the station SE. by E. Primitive rock forms the base of Capitol hill. The gneiss and mica schist is overlaid by alluvium of considerable thickness. Iron ore occurs in the vicinity of the city, but probably not near the station.
165(*b*)	East Capitol Garden, Washington, D. C.	38 53.3	77 00.1	2 01.0	71 19.6	4.308	1856. Aug. 15..........	About 162 yards east of the centre of Capitol dome, 50 yards south of the same, in the upper or east garden.
166	Oxford	38 41.4	76 10.2	2 41.3	70 58.0	4.384	Aug. 23.........	At the geodetic station on the shore of Third-haven creek. The soil consists of clay and marl, several feet in thickness, overlying sand mixed with marine shells.
167	Brown's island, Fredericksburg.	38 18.2	77 27.1	1 02.3	70 37.9	4.449	Sept. 17...	On Brown's island, close to the bridge and east of it. The little island is said to consist of made soil. The surrounding hills are covered to considerable depth with loam and gravel.
168	Mayo's island, Richmond.	37 31.7	77 25.7	0 14.5	69 47.7	4.609	Sept. 19.........	On Mayo's island, (the smaller one,) nearly due south of the Capitol. The instrument was mounted on the bare granite rock.

* See report of 1856.

APPENDIX No. 24—Continued.

Number.	Name of station.	Latitude.	Longitude.	Declination—west.	Dip.	Horizontal intensity.	Date.	Locality, geology, and remarks.
		° ′	° ′	° ′	° ′		1856.	
169	Cape Henlopen....	38 46.5	75 04.9	3 03.9	71 22.0	4.285	Aug. 27..........	1,170 feet from the light-house, which bears N. 57° E. (mag.,) near the edge of the woods on the summit of one of the sand dunes. The sand hills consist of white sand mixed with broken shells.
170	Dagsborough............	38 34.5	75 15.3	2 41.1	71 03.1	4.348	Aug 28..........	In the rear of Mr. Smith's inn, in the village of Dagsborough; the station is about 100 yards from the house in an open field. The soil consists of white sand and shells.
171	Mason's Landing.......	38 13.8	75 14.7	2 22.8	70 44.8	4.406	Aug. 30....	Near the mouth of Marshall's creek, close to the wharf of Mason's landing, and 115 feet north of the storehouse. The station was on the salt water marsh; around this marsh the soil consists of white sand mixed with shells.
172	Snead.................	37 58.3	75 25.9	2 18 4	70 31.0	4.448	Sept. 2.	In Mr. Snead's yard, 153 feet distant from the geodetic station, the same bearing S. 70° E. White sand mixed with shells.
173	Joynes	37 41.7	75 36.6	2 03.3	70 21.2	4.488	Sept. 4..........	1,130 feet from the geodetic station, and bearing N. 42° 56′ E., and close to the shore of Metomkin bay (outside the fence of the adjoining field.) The station is on the edge of the salt water marsh.
174	Scott..................	37 20.5	75 53.8	1 37.5	70 01.5	4.571	Sept. 6..........	Eighteen feet west of the geodetic station. Marshy soil; the white sand in the vicinity rests on a stratum of clay.
175	Cape Charles..........	37 07.3	75 57.9	1 35.2	69 43.3	4.622	Sept. 7..........	At the geodetic station. White sand mixed with broken shells. Station subject to overflow at high tides.
176	Old Point Comfort......	37 00.0	76 18.1	1 14.7	69 31.6	4.659	Sept. 8..........	Close to the beach in front of the light-house, east of the stone pier wharf. White sand mixed with shells.
177	Norfolk, (north station).	36 51.4	76 17.2	1 39.1	69 29.7	4.656	Sept. 9..........	In the yard of Mr. Lewellyn's premises, not far from the gas factory. City hall bears S. 10° 29′ E., distant 1,250 metres. Sandy soil.
177(b)	Norfolk, (south station).	36 50.5	76 16.8	1 33.3	69 28.2	4.667	Sept. 10.........	In the middle of Foster's lane, in an open lot, not far from Higgins' wharf. City hall 426 metres north, and 300 metres west, of the magnetic station. Sand and river deposit.
178	Cape Henry............	36 55.6	76 00.1	1 27.9	69 39.0	4.623	Sept. 11—12.....	Between the light-house and the beach, 226 feet east of the keeper's house; the light-house bears S. 26° 50′ W. White sand, with broken shells.
				East.			1857.	
125(b)	Savannah, Hutchinson's island.	32 05.3	81 05.2	3 27.5	63 44.3	5.664	May 1—2.........	Station identical with that occupied in April, 1852.
179	Fernandina............	30 40.6	81 27.7	4 01.8	62 07.3	5.889	April 6—20	At the geodetic station, Fernandina. White sand with broken shells.
180	Lower Peach Tree.....	31 50.4	87 32.6	6 02.4	62 16.8	5.968	April 30; May 5..	Forty-seven metres due north of the astronomical station. The geological formation is red clay, covered by a light sandy soil to the depth of 6 inches.
							1858.	
181	Pensacola, public square	30 24.6	87 11.5	6 47.3	61 05.9	6.127	June 21—23......	At the flagstaff, public square in Pensacola.
							1857.	
182	Mobile	30 41.6	88 01.8	6 52.2	60 51.0	6.143	Feb. 9—25.......	Public square, 210 feet north of the astronomical station. White sand 4 or 5 feet deep.
183	Barrel Key.............	29 54.3	89 07.0	....	59 48 2	6 225	April 14—18	The station is about 25 metres from the trigonometrical station, in back range with Martin's island. Barrel key is a small island, partly marsh and partly broken shells.
							1858.	
184	New Orleans	29 57.4	90 04.2	7 51.5	59 46.5	6.286	April 6—8........	Public square in Basin street; the magnetic station is at a point 84 feet in a southwestern direction from the astronomical station. The geological formation appears to be chiefly sand, covered to the depth of 2 or 3 feet by a rich soil.
							1856.	
185	Point Hudson...........	48 07.0	122 44.6	21 39.5	....	....	Aug. 17—20.......	The magnetic station is on the line to Admiralty Head, and distant from the geodetic station, Point Hudson, about 170 yards.

APPENDIX No. 25.

Rediscussion and development of an intermediate period in the secular change of the magnetic declination at Hatboro', Pennsylvania.

COMPUTING DIVISION, COAST SURVEY OFFICE,
October 28, 1858.

DEAR SIR: Following up the revision of the investigation of the secular change of the magnetic declination by the application of a circular function, I herewith respectfully submit the results of a discussion at a second station, Hatboro', Pa., on account of a new feature first recognized at this place, and since confirmed, as to its existence, at Burlington, Vt., and Providence, R. I. It is the presence of a secondary period within the primary one. At Hatboro' this shorter period is gone through in about 88 years, while the longer one requires nearly 234 years; the range of this secondary motion is $\frac{1}{15}$ nearly of that of the primary. The length of the shorter period, as well as its epoch and range, is variable with different localities. The result of my first investigation (Coast Survey Report of 1855, Appendix No. 48) considerably facilitates the present discussion, in which I was assisted by Mr. Wiessner. For the representation of the Hatboro' observations I adopted the form

$$D = d + r \cos. (a\, n + c) + r_1 \cos. (a_1\, n + c_1)$$

where $n =$ the number of years $\left\{ \begin{matrix} + \text{ after} \\ - \text{ before} \end{matrix} \right\}$ an assumed epoch, here the year 1830.

In the numerical application, the last term of the equation being at first neglected, the form adopted for the conditional equations was

$$o = -D + d_1 + x + \cos.\, a\, n\, r \cos.\, c - \sin.\, a\, n\, r \sin.\, c$$

of which equations there are 18, furnishing three normal equations for finding the values of x, r and c. The first assumption was $d_1 = +5.2$ and $a = \frac{360}{250} = 1.44$, as pointed out by the former discussion. In a second and third assumption a was varied, and the corresponding values for x, r and c determined as before. Next: that particular value for a was found which makes the sum of the squares of the remaining differences a minimum. The following expression for the declination was found in this manner—

$$D = +5^{\circ}.23 - 3^{\circ}.28 \cos. (1^{\circ}.54\, n + 46^{\circ}.8.)$$

Comparing the results by this formula with the observed declinations, it leaves the remainders given in the annexed table in the column headed "difference." These remainders (with their signs changed) compare very favorably with the corresponding values given in the report for 1855, p. 313; the present discussion making the probable error of observation $\varepsilon_0 = \pm 8'.6$, when the former made it $\pm 11.'0$.

It is evident, from either set of residuals, that there is a second period within the former whose approximate duration is 88 years, with a radius of about $\frac{1}{4}$ of a degree. The term $+ r_1 \cos. (a_1\, n + \cos.\, c_1)$ was, therefore, added to the above formula. The numerical values were obtained in a similar manner as before, with the difference, that $\Sigma\, \Delta$ instead of $\Sigma\, \Delta^2$ was made a minimum; the application of the method of least squares being only applied for finding r and c.

The complete expression becomes

$$D = +5^{\circ}.23 - 3^{\circ}.28 \cos. (1^{\circ}.54\, n + 46^{\circ}.8) + 0^{\circ}.22 \cos. (4^{\circ}.1\, n - 13^{\circ}.)$$

Comparing the results with the observations, it leaves the residuals exhibited in the column headed Δ. They still show a regularity in the change of the signs; but, for the present, it was not thought necessary to pursue the inquiry any further. The corresponding ε_0 is now reduced to $\pm 5'.2$.

TABLE.

Year of observation.	Observed declination.	Difference.	Computed declination.	Δ
	°	°	°	°
1680	+ 8.47	— 0.03	+ 8.49	— 0.02
1690	8.25	— 0.20	8.30	— 0.05
1700	7.92	— 0.24	7.94	— 0.02
1710	7.47	— 0.20	7.49	— 0.02
1720	7.00	0.00	6.95	+ 0.05
1730	6.42	+ 0.22	6.30	+ 0.12
1740	5.58	+ 0.22	5.56	+ 0.02
1750	4.92	+ 0.46	4.67	+ 0 25
1760	4.00	+ 0.36	3.75	+ 0.25
1770	2.92	— 0.02	2.90	+ 0.02
1780	2.08	— 0.31	2.22	— 0.14
1790	1.83	— 0.23	1.84	— 0.01
1800	1.92	— 0.03	1.79	+ 0.13
1810	2.00	— 0.08	2.06	— 0.06
1820	2.45	+ 0.02	2.56	— 0.11
1830	3.00	+ 0.02	3.19	— 0.19
1840	3.83	+ 0.13	3.89	— 0.06
1850	+ 4.42	— 0.12	+ 4.61	— 0.19

The condition of the minimum declination is expressed by the formula $o = 5.05$ sin. $(1°.54\ n + 46°.8) - 0.90$ sin. $(4°.1\ n - 13°)$ from which $n = -33.7$ years; hence the minimum occurred in 1796.3. The effect of the last term in the expression for the declination is to place the minimum 3.3 years earlier. The former discussion (in 1855) placed the minimum in 1806.1 ± 19.3 years, and the mean from all stations then discussed gave 1797.6 ± 1.8 years. By a first differentiation of the formula we obtain the expression for the annual change v, expressed in minutes, as follows:

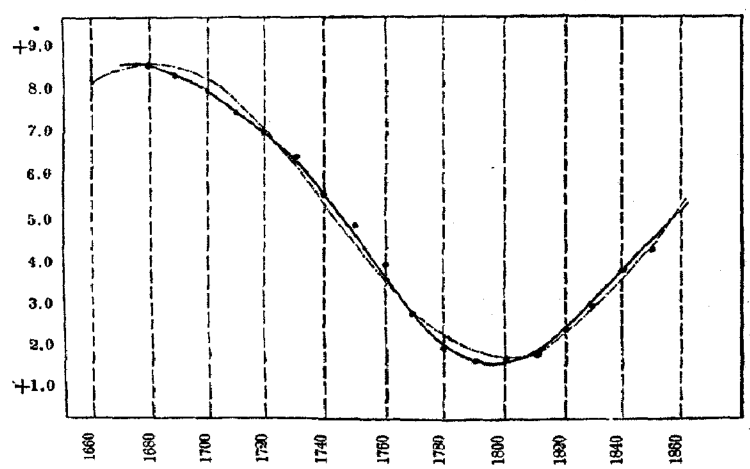
$$v = +\ 5'.29 \text{ sin. } (1°.54\ n + 46°.8) - 0'.94 \text{ sin. } (4°.1\ n - 13°)$$

and, by second differentiation, the expression for the condition of the maximum annual change becomes

$$o = +\ 7.77 \text{ cos. } (1°.54\ n + 46°.8) - 3.69 \text{ cos. } (4°.1\ n - 13°)$$

which equation is satisfied for $n = +\ 45.2$, or the maximum annual change will occur in 1875.2. There the additional term in the expression for the declination shifted this epoch from 1858.1 to the above year.

I append some values of v, viz: in 1840 .... + 4'.2 maximum value + 4'6
1850 .... + 4'.3
1860 .... + 4'.4



From the observations since 1750, separately discussed in 1855, the table on p. 335 of the report for that year gives for v, in 1850, $+ 6'.8$; also, $\varepsilon_0 = \pm 8'$ and $T = 1799.5$; which results may be compared with the above.

On the accompanying diagram I have indicated the observations by dots, the computed declination by a curved line, and, for the purpose of comparison, the declination resulting from the use of a single period by a closely dotted curve.

Yours, very respectfully,

CHAS. A. SCHOTT,
Assistant in charge Computing Division.

Captain W. R. PALMER,
U. S. Topographical Engineers, Assistant in charge C. S. Office.

APPENDIX No. 26.

Report to the Superintendent by Assistant Charles A. Schott, on the progress made in discussing the secular variation of magnetic declination and dip for Washington City, D. C.

COMPUTING DIVISION, COAST SURVEY OFFICE,
June 24, 1858.

DEAR SIR: I herewith respectfully submit the result of my latest discussion of the secular variation of the magnetic declination and dip for Washington City, D. C.

The magnetic station in this city offering peculiar facilities for the comparison of different instruments, I have commenced a second step in the discussion, viz: the introduction of a convenient circular function, with the observations on hand for the above station, and referring in particular to Capitol Hill on account of the very considerable local deviation in another part of the city. It suffices for the present to use a circular function in its simplest form, the results answering for any time between 1679 (the period of the last maximum of declination) and the present date, or as far removed from either limit as we may feel disposed to trust to the continuation of the law as it has hitherto manifested itself. The duration of the period, from the occurrence of its subdivisions, seems to shorten, and an extension of the formula, beyond either limit, is to be looked upon as precarious. The present formula for the change of declination (and it is intended to bring up others gradually, as the material increases, to the same form) is based upon the principal results of the first discussion, (C. S. Rep. 1855, pp. 306—337,) viz: the resulting epoch of the last minimum in 1797, 6 ± 1.8 years, and the probable duration of the period from maximum to minimum of 237 years $\pm$ an uncertainty of several years.

Let $D =$ the magnetic declination ($+$ when west, $-$ when east) at any time within the limits stated.

Let $d_1 =$ an assumed value of the declination for the time of its mean value, or for the time of the occurrence of the maximum annual change. It may be taken equal to the observed minimum, increased by half the range between the extremes. This time is somewhat later than the year 1850.

Let $x =$ a small correction to the above, to be determined by the method of least squares: then $d_1 + x = d$.

Let $r =$ the radius or half the range, also to be determined by least squares.

Let $a =$ the angle (expressed in degrees) corresponding to one year of the period p.

Let n = the number of years (+ after, — before) from the minimum in 1797.5. We then have

$$D = d_1 + x + r \cos (n\, a.)$$

On account of the present greater change in the cosine, it has been preferred to the sine.

Putting $p = 240^y$, hence $a = \frac{360}{240} = 1.5$, we find for Washington—

$$D = +\, 2^\circ.42 - 2^\circ.0 \ \cos.\ (1^\circ.5n)$$

in which expression a consideration of weights changed the original least square co-efficient $- 1^\circ.8$ into $- 2^\circ.0$.

The observations are represented as follows:

Year.	Observed D.	Computed D.	C — O.	Remarks.
	°	°	°	
1809.0	+0.87	+0.52	—0.35	See preliminary discussion, Coast Survey Report, 1855, page 334.
1840.5	+1.37	+1.56	+0.19	
1841.5	+1.40	+1.60	+0.20	
1855.5	+2.40	+2.32	—0.08	
1856.6	+2.36	+2.38	+0.02	C. A. Schott, observer.
1857.2	+2.41	+2.40	—0.01	W. Read, observer.

By differentiation I find for the annual change $v = - \frac{60\, r\, a}{57.3} \sin\, (a\, n)$ expressed in minutes; and for 1858.5, $v = +\, 3'.1$. It is evident that the first observation by King yet reacts unfavorably on the second and third of Gilliss, but this may be corrected by future observations. The maximum declination at the close of the last century was, accordingly, $+\, 2^\circ.42 - 2^\circ.0 = +\, 0^\circ.42$, or the line of *no variation* in its highest ascent at that period passed below Washington. It certainly passed above Norfolk. The maximum declination will probably be $+\, 2^\circ.42 + 2^\circ.0 = 4^\circ.42$.

For the *dip* we have yet to retain a linear function, the period being entirely unknown. A comparison with the discussion (C. S. Rep., 1856, pp. 242, 243) will show the improvements made.

$$I = +\, 71^\circ.29 - 0.0070\ (t - 1840) + 0.00076\ (t - 1840)^2.$$

Year.	Observed I.	Computed I.	C — O.	Remarks.
	°	°	°	
1839.2	71.29	71.30	+0.01	
1841.0	.30	.28	—0.02	Present annual variation, $v = +1'.2$.
1842.5	.22	.28	+0.06	
1844.4	.27	.27	0.00	
1851.5	.32	.31	—0.01	
1852.4	.39	.32	—0.07	
1853.4	.36	.33	—0.03	Observed by Lieut. Gilliss.
1855.7	.47	.35	—0.12	
1856.6	.34	.36	+0.02	Additions to report of 1856; first and last observations by C. A. Schott, the middle one by Mr. Read.
1857.2	.38	.39	+0.01	
1858.4	.38	.42	+0.04	

The last three observations served for testing a number of needles, and, by observation, the index error for any new needle may now be found with considerable accuracy.

The minimum occurred in the summer of 1844.

Yours, very respectfully,

CHAS. A. SCHOTT,
Assistant in charge of Computing Division.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 27.

On the tidal currents of New York harbor near Sandy Hook, by A. D. Bache, Superintendent United States Coast Survey.—(SKETCH No. 39.)

[Communicated by authority of the Treasury Department to the American Association for the Advancement of Science.]

In a former notice of the observations of tidal currents near Sandy Hook I stated the general character of the results obtained, and their specific bearing upon the explanation of the growth of Sandy Hook, and of the changes above and below water in its vicinity. I propose now to describe more in detail the observations themselves, to discuss numerically and by the aid of diagrams the results obtained, and to show from them how the Hook is built up, the False Hook channel deepened, and Sandy Hook bay modified in its shore line, and especially in the configuration of the bottom.

Sketch No. 1 shows the current stations occupied on the outside of the Hook, and in False Hook channel and the approaches, in the different parts of the main ship channel and its approaches, and in the eastern, middle, and western portions of Sandy Hook bay.

It will be convenient to discuss the subject under the three divisions already referred to, of (1) the normal currents in the main ship channel and its approaches, of (2) the currents of False Hook channel and the approaches, and (3) the currents of Sandy Hook bay.

1. *Normal currents at the entrance to New York Bay.*—Diagram 1 (sketch 2) shows the comparison of the average tidal currents at three groups of stations; the most eastern, comprehending the positions R_2, R, Q, and H, shows the currents at and within the bar in the vicinity of Gedney's channel; the middle, embracing the stations P, O, I, A_2, A, lying for the most part between the eastern portions of Flynn's Knoll and the point of Sandy Hook, shows the currents of this part of the main ship channel; while the western group, B, and B_2, gives the currents for the western part of the main ship channel in the vicinity of the Southwest Spit. Diagram 1 (sketch 2) also exhibits the type form of the tide wave as observed at Sandy Hook. The currents are plotted for flood and ebb, above and below a common axis, which corresponds to the mean level of the sea. These curves are plotted in their true relative positions to the tide wave as regards their epochs.

Table 1 contains the *dates, names of stations, localities, luni-current intervals, durations, intervals after the tide wave, velocities, and directions* of the currents. In this table are given the numerical results from all the stations to which we have referred, reduced to their mean values. In table 2 the averages for the groups are given.

From the first line of table 2 we find that about 56^m after the time of high water at Sandy

Hook, the ebb current begins to make in the locality covered by the eastern group of stations running east by south, reaching its greatest rate of about 1.71 miles per hour, (in about three hours,) and then decreasing (in about three hours) to zero, and turning to flood at about 1^h 33^m after the time of low water, the ebb thus being estimated at 6^h 19^m. The flood reaches its maximum in about 3^h when its rate is 1.11 miles per hour, running generally northwest for about 5^h 43^m, and reaching slack water about 56^m after the time of high water at Sandy Hook. The times of running ebb and flood are nearly equal. The greatest rates are as 17 to 11, and the average as 10 to 6.

Line 2 of table 2 gives the results from the middle group of stations, from which it appears that in that portion of the main ship channel lying north of Sandy Hook the ebb currents run generally east by south; the flood west by north. The ebb has a less velocity, and the flood a greater, than for the eastern group. The maximum velocity of ebb is 1.47 miles per hour, and of flood 1.68 miles; the mean velocities of ebb 1.09, and of flood 1.04 miles. The reason of this change of proportion between the maximum and mean velocities of the ebb and flood currents is obvious from an inspection of the type curve. It will be seen that the ebb is characterized by a uniformity of rate during the second, third, and fourth hours of its existence, while the curve for the flood resembles the curve of sines. The ebb current turns earlier, lagging but 22^m after low water; thus turning more than 30^m before the corresponding currents to the eastward. The 3d line of table 2 shows the results for the western group in the vicinity of southwest spit. Here the currents have a course round the compass, are much less rapid than the others, and are earlier.

It would be curious to know where the earliest turning of the current is to be found; and, indeed, these results open up many questions in regard to the whole bar and the channels through it. For our present purpose we have limited ourselves to obtaining the means of comparison of the normal currents sweeping by the point of Sandy Hook with those secondary ones which we shall next proceed to trace.

2. *False Hook channel and the approaches.*—The results from the current stations S, T, C, D, G, F, and V (see sketch 1 and table 3) show the movements of the water in this channel and its vicinity. Stations at E and "off Long Branch" lie quite to the southward. S shows the action at the northern entrance and V at the southern; C in mid-channel. T, at the entrance, is influenced by the shoals of the False Hook; G, F, and V, between the ocean and False Hook channel, are unsatisfactory; D shows the shore currents of Sandy Hook.

The results from these stations are given in table 3, which is constructed in a manner similar to table 1, already described. Treating S, T, C, F, and G together as a group, we have for the luni-current interval 8^h 20^m, or 58^m after the time of high water at Sandy Hook for the commencement of ebb, the current of ebb beginning earliest at S, G, T, the flood first at F, S, T. The interval of ebb is about the same as that of the vicinity of Gedney's channel; the flood three quarters of an hour earlier. This gives above a half hour for the differences of duration between the main ebb and flood, and the corresponding ones of this part of the approach to New York harbor. The currents at stations T, S and G are plotted upon diagram 2, sketch 2.

The mean epochs (Table 4) are *8h. 14m.* and *14h. 02m.*, being *17m.* and *46m.* less than those found for the vicinity of Gedney's channel. The flood exceeds the ebb about *24m.*, whereas for the stations near Gedney's channel the ebb exceeds the flood by about *34m.*, and in the South channel the ebb has greatly the advantage both in duration and velocity. This shows the influence of the secondary or draught currents through the False Hook channel.

The average maximum velocity at these stations of both flood and ebb is 1.41 miles, which last, in the vicinity of Gedney's channel, was 1.71 miles. The mean velocity of the ebb is but 0.91 miles, which was 1.03 miles for the stations near Gedney's channel, and about the same at Station S.

The ebb makes out but slowly through the False Hook channel; the maximum velocity of the flood at C is 1.62 miles, and of the ebb but 0.78, and the means 1.02 and 0.50 miles per hour. The time during which the ebb runs is 5*h.* 41*m.*, and the flood 7*h.* 08*m.*, a difference of 1*h.* 27*m.*, and this in the axis of the stream. As the scouring action of these currents may be regarded as varying with the product of the square of the mean velocity and the duration, we have for Station C the ratio of about 1 to 5 for the relative work of ebb and flood. At the edge of the False Hook shoal the duration of the ebb appears to be even less, there being but 5*h.* 20*m.* of ebb. The currents at C are plotted with the tide wave on Diagram 3, (Sketch 2.) It appears that the curve representing the flood drift approaches the type form while the ebb is anomalous—it is weak and inconstant.

We are now prepared to find the shore currents such as the observations prove them to be. The results at Station D, off the wreck of the brig Commerce, are shown in Diagram 4, (Sketch 2,) where they are compared with the tide wave of July 18. The flood runs for 7*h.* 15*m.* out of 12*h.* 42*m.* The greatest velocity of the flood is 1.23 miles against 0.62 of the ebb. The directions are nearly opposite. The currents "off Long Branch," at Station E, at Station D and at Station 9, near point of Sandy Hook, are shown on Diagrams 4 and 5, (Sketch 2.) The ebb currents are quite feeble in both. It is the shore current, just discussed, which transports materials to the end of Sandy Hook; it is the grand current, in fact, which makes the False Hook channel; and the False Hook occupies the debateable ground between the outside and False Hook channel currents at certain times of tide, and is built up by the slackening ebb. In this point of view the shoal tends to restore equilibrium. The difference of action of flood and ebb is defined by this shoal. At Station V, on the southern extremity of the outer middle ground, and in close proximity to the lower entrance of False Hook channel, the currents are feeble, and an equilibrium of ebb and flood drifts seems to be established. It would appear that the scouring action of the tidal currents is insufficient to keep the bar of this channel open.

It is the material carried along the outer shore of Sandy Hook, and deposited at the point, which chiefly causes the growth of the Hook. Whenever it shall be considered desirable to limit this increase, it will be easy to do so by a series of jetties so placed as to arrest the movement of the sand to the northward, successive structures stopping the material which may pass round the point of the more southwardly jetties.

3. *Currents of Sandy Hook bay.*

To obtain a clear idea of the tidal currents of Sandy Hook bay, let us suppose it divided into three sections—eastern, middle, and western—and ascertain the relations of direction at successive periods. To this end we arrange the results according to the twelve tidal hours, calling the epoch of low water 0*h.*, the epoch of high water 6*h.*, &c.

The flood current commences in the main ship channel and in Sandy Hook bay at nearly the same period, viz: about 1*h.* 04*m.* after the time of low water. The water of the main ship channel now flows to the westward, that of the eastern section of the bay to the southward, that of the middle to the southwest, and that of the western section to the west. This general condition continues for about two and a half hours, and is exhibited upon Diagram 1, (Sketch 3.) It will be noticed upon this diagram that a limited region about the point of Sandy Hook is subject to a counter drift or whirl. This whirl is increasing in size, and its axis is moving southward; its existence is due to the lateral draught produced by the strong and steady stream of the ship channel, to which we shall refer hereafter. At 3*h.* the effect of this lateral draught on the eastern section is already seen in the slacking up of the currents, and at 4*h.* it has completely reversed the direction of the drifts. At this period (4*h.*) the conditions are exhibited by Diagram 2, (Sketch 3.)

The currents are northward (with velocities of 1.4 and 0.3 miles per hour at stations near to and more remote from the main ship channel) in the eastern, southwestwardly (with velocity 0.3) in the middle, and westwardly (with velocity 0.4) in the western section of the bay, while the current of the main ship channel, now at its maximum, holds a course due west, with a velocity of 1.9 miles per hour. At 5*h.* this whirl has extended to the middle section of the bay, reversing the currents of that region.—(See Diagram 3, Sketch 3.) Its axis still moves to the southward, and at 6*h.* there occurs a space of slack water, near the point of Sandy Hook, where we at first noticed the existence of the whirl that we have followed. The currents are now diminishing rapidly in the main ship channel, as well as in the western section of the bay, and at 7*h.* we find the ebb current prevailing. At first the course of the ebb currents of Sandy Hook bay may be represented by straight lines converging to a point, in the ship channel north of Sandy Hook, but these lines of direction gradually curve to the southward, until, as in Diagram 4, (Sketch 3,) which represents the conditions at the 9th hour, the waters of Raritan bay press into Sandy Hook bay, then, escaping along the shore of Sandy Hook, rush into the ship channel, causing a rip and counter drift at the point of the Hook. At this time (9*h.*) the current of the main ship channel runs east, (velocity 1.3 miles per hour;) that of the eastern section of the bay north, (velocity 0.5;) that of the middle east by south, (velocity 0.5;) and that of the western east by south, (velocity 0.2.)

The point of greatest curvature, in the sweep of the ebb drift through Sandy Hook bay, moves continually to the westward, as will be seen by comparison of the conditions at 9*h.* and 11*h.*—(See Diagrams 4 and 5, Sketch 3.) This grand movement ultimately creates a counter drift near the point of the Hook, which assumes the form of a whirl as the current of the ship channel slackens. The ebb (northwardly) is the dominant current in the eastern section of Sandy Hook bay; it commences to prevail three hours before the flood of the ship channel slackens. It is evident that this earlier drift is the lateral draught created by the stream of the ship channel, since, as we have previously shown, its domain increases with the velocity of the main stream, and it prevails generally in the eastern section of the bay when the main stream has reached its maximum velocity. Moreover our several stations show that the duration and velocity of this northwardly drift are alike dependent upon the distance from the ship channel.

Lines 1 and 4 of table 6 give the averages of the maximum velocities at several stations, as 1 mile of ebb against 0.4 of flood, and the mean velocities 0.6 of ebb against 0.2 of flood. The mean durations are more than 10 hours of ebb against less than 2 hours of flood.

In the middle of Sandy Hook bay the ebb current begins nearly two hours before slack water in the main ship channel; its general course is south by east, that of the flood being east by north. The average maximum velocities given by the 5th line of table 6 are 0.6 of ebb against 0.4 of flood; the mean rates are above 0.4 of ebb against 0.2 of flood. The durations are about eight and a quarter hours for ebb and three and a half for flood. In the western section of the bay the ebb commences at nearly the same period as in the main ship channel. The average velocities are nearly equal, and the durations are more nearly so than for the other portions of the bay.

The scouring done by these currents will vary with the product of the duration and the square of the mean velocity if the material to be acted upon is the same. In the eastern section, therefore, the work done by the ebb is to that done by the flood as 45 to 1. In the middle section the work done by the ebb and flood will be as 9 to 1; while in the western section the feeble labors of ebb and flood are nearly equal, and their directions so nearly opposed that little ultimate scouring is effected. The form of the bottom is in accordance with these results.

Since the tide wave is propagated most rapidly in deep water, it follows that the fall of the tide takes place earlier in the channel than upon the shore; hence the water tends to flow laterally *from* the shore *towards* the channel. In this way a convergence of the ebb streams may be expected, especially in shallow bays. With the flood streams the reverse must be true, and the tide wave rising earlier in the channel a flow of water takes place towards the shore. In consequence of these distinctive characteristics the ebb and flood assume an unequal share in the moulding of sandy coasts. The ebb current, with its concentration of forces, is a far more powerful agent than the flood; its scouring capacity along its normal course must be more considerable, and it creates more extensive draught currents. The secondary or draught currents within Sandy Hook, called into activity by the unnaturally constrained flood of the ship channel, cover a district not above one and a half mile in extent, while the draught of the ebb upon the outer shore is sensibly felt twelve miles down the New Jersey coast; it is felt at Long Branch, where the primary ebb and flood are almost extinct.

Again: The ebb stream holds its course across the middle of shallow basins, in a narrow stream; while the flood, dispersive in its character, pursues the broadest possible path and presses along the shores. We are prepared, therefore, even in the absence of draught currents, to find the flood predominating over the ebb in certain localities near the shore.

It is not probable that the axis of the grand ebb current has moved northward to avoid Sandy Hook, but rather that it naturally converges at the mouth of New York harbor, and that the weaker flood has not been able to destroy the work which the ebb has *directly* or *indirectly* accomplished. It is true that the flood, at the point of the Hook, is sweeping the sand inward—that, in fine, it is giving this spit of land the *hook form;* but the ebb is the primary working agent, and the characteristic features of all channels and basins, on alluvial tidal coasts, must, as a rule, reflect the efforts of the ebb current.

That part of the growth of the Hook which takes place from the inside, and which is not so considerable as that from the outside, is caused by the draught current along the shore, which we have been engaged in studying. The action of the waves undoubtedly contributes, by the stranding of the material, to this growth. The material on the inside is less favorable to the action of transportation, and the currents are lost at a moderate distance from the extremity of the Hook.

TABLE No. 1.

Date.	Station.	Locality.	Lunar current interval.		Duration of current.			Interval after tide of Sandy Hook.		Velocity of currents in nautical miles per hour.				Direction of current.				Remarks.
										Max.		Mean.		At max.		General.		
			Ebb.	Flood.	Total.	Ebb	Flood.	Ebb after h.w.	Fl'd after l.w.	Ebb.	Flood.	Ebb.	Flood.	Ebb.	Flood.	Ebb.	Flood.	
1856.			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	m. dec.	m. dec.	m. dec.	m. dec.					
Aug. 2	R	West end of Gedney's channel	8 32	14 53		6 21		1 05	2 10	2.14	1.15	1.22	0.47	E. by S.	NW.	E. by S.	NW	
	Q	Between R and P	8 42	14 47		6 05		1 15	2 04	2.17	1.15	1.11	0.80	E.	W.NW.	E.	NW.byW.	
July 13	R_2	East end of Gedney's channel	8 47	14 57	12 30	6 10	6 20	0 55	0 55	1.15	0.74	0.70	0.57					
23	H	Junct'n of Swash and Gedney's ch'l.	8 02	14 36	12 31	6 34	5 57	0 30	1 04	1.37	1.42	1.10	0.72	E. by S.	NW.	SE.	NW.	
Aug. 1	P	SE. of *Flynn's knoll*	7 48	14 48		7 00		0 20	1 19	1.90	1.42	1.15		E.NE.	W.NW.	E. by N.	NW.byW.	
	O	Main ship chan'l, near Flynn's knoll.	8 18	14 23		6 05		0 50	1 27	1.02	1.53	0.80	0.86	E.	NW.	E.	NW.byW.	
July 15	A_1	Main ship channel, N. of E. Beacon.	8 30	15 25	12 00	6 55	5 05	0 16	1 09	1.32	1.90	1.02	1.15	E. by S.	W.	E.SE.	W.	
23	I	Near O	8 12	14 35	12 23	6 23	6 00	0 15	0 37	1.63	1.50	1.39	1.10	E. by S.	W. by N.	E. by S.	W. by N.	
15	A_2	Middle of ship channel	7 43	14 31		6 48		0 11	0 36		2.07				W. by N.		W. by N.	
	B_2	S. of SW. spit	7 46	14 16	12 08	7 08	5 00	— 10	1 00	1.12	0.43	0.47	0.26	E.	NW. by W	round the	compass.	
16	B	Near B_2	8 12	15 58														

TABLE No. 2.

Date.	Station.	Locality.	Lunar Ebb.	Lunar Flood.	Dur. Total.	Dur. Ebb	Dur. Flood.	Ebb after h.w.	Fl'd after l.w.	Max. Ebb.	Max. Flood.	Mean Ebb.	Mean Flood.	At max. Ebb.	At max. Flood.	General Ebb.	General Flood.	Remarks.
	R Q R_2 H.		8 31	14 48		6 17		0 56	1 33	1.71	1.11	1.03	0.64			E. by S.	NW.	
	P O A_1 I A_2.		8 06	14 44		6 38		0 22	1 04	1.47	1.68	1.09	1.04			E. by S.	W. by N.	
	B_2 B.		7 59	15 07		7 08		— 10	1 00	1.12	0.43	0.47	0.26	round the	compass.			

TABLE No. 3.

Date.	Station.	Locality.	Lunar Ebb.	Lunar Flood.	Dur. Total.	Dur. Ebb	Dur. Flood.	Ebb after h.w.	Fl'd after l.w.	Max. Ebb.	Max. Flood.	Mean Ebb.	Mean Flood.	At max. Ebb.	At max. Flood.	General Ebb.	General Flood.	Remarks.
July 15	U	South channel, east of Main Light.	8 34	15 41	13 17	7 07	6 10	20	1 25	1.30	1.00	0.71	0.52					
18	C.	Middle of *False Hook* channel	8 28	14 09	12 49	5 41	7 08	50	25	0.78	1.62	0.50	1.02	SE.	N. by W.			
21	F.	West side Oil Spot	8 28	13 48		5 20		1 08	28	0.62	0.95	0.35	0.60	S.SE.	NW.	SE.	NW.	
	G.	East side Oil Spot	8 11	14 09		5 58		1 10	55	1.04	1.14	0.73	0.62	SE. by S.	N. by W.	SE.	N. by W.	
24	9.	East of Stake No. 19.	7 07	10 36		3 29		— 25	-3 05	0.35	1.01	0.20	0.40	SE.	NW. by N.	SE.	NW.	
18	D.	East of Main Light, 500 ft. from shore.	8 02	13 29	12 42	5 27	7 15	30	— 20	0.62	1.23	0.15	0.72	S.	N.	S.	N. by W.	Shore currents from north end of Sandy Hook to Long Branch, N. J., in 12 to 18 feet of water.
	E.	Off Ocean House, 500 ft. from shore.	7 37	11 46	12 09	4 09	8 00	1 15	-2 30	0.17	0.15	0.12	0.07	S.	N.	S.	N.	
21		Long Branch, 500 feet off shore	10 42	11 49	11 07	1 07	10 00	3 28	-1 25	0.10	0.15	0.01	0.03	S.SW.	N. by E.	E.	N.	
Aug. 4	S.	Outside False Hook, north end	8 09	13 55		5 46		40	50	1.77	1.64	1.06	1.10	SE.	NW. by N.	SE.	NW. by N.	
	T.	Southeast of Station S.	8 22	14 03		5 41		1 00	55	1.44	1.44	0.05	0.86	SE.	NW.	SE	NW. by N.	
July 19	V.		8 09	14 31	12 22	6 22	6 00	— 20	1 00	0.20	0.20	0.10	0.12					

TABLE No. 4.

Date.	Station.	Locality.	Lunar Ebb.	Lunar Flood.	Dur. Total.	Dur. Ebb	Dur. Flood.	Ebb after h.w.	Fl'd after l.w.	Max. Ebb.	Max. Flood.	Mean Ebb.	Mean Flood.	At max. Ebb.	At max. Flood.	General Ebb.	General Flood.	Remarks.
	S T C F G.		8 20	14 01		5 41		0 58	0 43	1.13	1.36	0.72	0.84			SE.	N.NW.	
	U.	South channel, east of Main Light.	8 34	15 41	13 17	7 07	6 10	20	1 25	1.30	1.00	0.71	0.52					
	G S T.		8 14	14 02		5 48		0 57	0 53	1.41	1.41	0.91	0.86			SE	NW. by N.	

TABLE No. 5.

Velocities corrected for diurnal and half-monthly inequalities.

Date.	Station.	Locality.	Lunar current interval. Ebb.	Lunar current interval. Flood.	Duration of current. Total.	Duration of current. Ebb.	Duration of current. Flood	Interval after tide of Sandy Hook. Ebb after h.w.	Interval after tide of Sandy Hook. Fl'd after l.w.	Velocity of currents in nautical miles per hour. Max. Ebb.	Velocity of currents in nautical miles per hour. Max. Flood	Velocity of currents in nautical miles per hour. Mean. Ebb	Velocity of currents in nautical miles per hour. Mean. Flood.	Direction of current. At max. Ebb.	Direction of current. At max. Flood.	Direction of current. General. Ebb.	Direction of current. General. Flood.	Depth in feet.	Remarks.
			h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	m. dec.	m. dec.	m. dec.	m. dec.						
1856.	No. 7......	Near end of Hook, 200 ft. off shore.	3 30	14 51	12 21	11 21	1 00	—4 15	1 15	1.40	0.23	0.58	0.12	N.NE ...	N. by W.	N. by E.	NW.....	28	Shore currents.
	No. 6......	500 ft. S. of Sta. 7, 200 ft. off shore.	3 18	14 37	12 24	11 19	1 05	—4 20	0 35	1.57	1.02	1.09	0.57	NE......	SW.....	NE......	SW.....	...	
	No. 5......	Off W. Beacon 600 ft., and 400 ft.	5 07	14 42	13 45	9 35	4 10	— 40	— 30	? 0.78	? 0.46	? 0.46	? 0.21	N.NW ..	S.	N.NW ..	S........	6	
		from shore....................	4 20	14 59	13 14	10 39	2 35	15	—2 50	0.78	0.15	0.43	0.11	N. by E..	SE. by S.	N.......	SE.......	7	Inside Sandy Hook, N. J.
	No. 4......	Off tide-gauge, west of light-house	5 23	14 18	12 25	8 55	3 30	— 30	0 20	? 0.43	0.54	0.30	0.35	N. by E..	S.	N. by E..	S.	12	
	K..........	2,200 ft. off shore, SW. of W. Beacon	4 32	14 19	12 12	9 47	2 25	—3 08	0 40	0.76	0.21	0.44	0.05	N.NE....	S. by W.	N.NE....	S.	24	
	L_1.........	3,600 ft. off shore, W. of light-house.	5 09	14 34	11 36	9 26	2 10	—3 25	0 40	0.61	0.35	0.39	0.16	N. by E..	S. by E..	N.......	S. by E..	24	E'rn portion Sandy Hook bay.
	L_2.........	1,200 feet SW. of L_1............	5 28	14 27	11 39	8 59	2 40	—2 40	0 40	0.50	0.23	0.32	0.07	N.......	S.	N.......	S.......	25	
	M_1.........	W. of light-house, mid. of S. H. bay	6 38	14 29	12 02	7 51	4 11	—1 50	1 45	0.32	0.69	0.43	0.26	NE......	E.SE....	NE......	E.SE....	25	
	M_2.........	2,000 feet northeast of M_1........	5 58	14 42	11 24	8 44	2 40	—1 50	1 40	0.80	0.47	0.45	0.15	E. by N..	SE......	E. by N..	SE......	27	Middle of Sandy Hook bay.
	M_3.........	2,000 feet north of M_1............	6 10	14 29	11 49	8 19	3 30	—1 45	00	0.78	0.16	0.45	0.03	E.SE....	SW.....	E.SE....	SW	30	
	N_1.........	West of light-house, north of Port																	
		Monmouth....................	8 23	14 43	....	6 20	......	—0 35	....	0.30	0.52	.....	......	SE	W	E.......	W	18	
	N_4	Between N_1 and N_2...........	7 45	14 29	12 54	6 44	6 10	0 35	— 20	0.36	0.42	0.17	0.21	E. by N..	W. by N	E.......	W	30	W'rn portion Sandy Hook bay.
	N_3	North end of Port Monmouth dock	7 58	13 52	13 24	5 54	7 30	0 10	—1 35	0.26	0.46	0.17	0.23	NE......	W.NW..	NE......	W	8	

TABLE No. 6.

	Nos. 7 & 6.	....	3 24	14 44	12 22	11 20	1 02	—4 18	55	1.49	0.63	0.83	0.34	....	....	N. by E.	W	28	NE. portion of Sandy Hook bay.
	No. 5......	....	4 43	14 50	12 29	10 07	3 22	— 12	1 40	0.78	0.30	0.44	0.16	....	....	N. by W.	S. by E..	6	Shore currents, Sandy Hook.
	No. 4......	....	5 23	14 18	12 25	8 55	3 30	— 30	0 20	0.43	0.54	0.30	0.35	....	....	N. by E..	S., ...	12	
	K L_1 L_2....	....	5 05	14 27	11 47	9 22	2 25	3 04	40	0.62	0.27	0.38	0.09	....	....	N........	S........	24	E'rn portion Sandy Hook bay.
	M_1 M_2 M_3	....	6 16	14 33	11 47	8 17	3 30	—1 47	1 08	0.63	0.44	0.44	0.15	....	....	E. by N.	S. by E..	27	Middle portion Sandy Hook bay.
	N_1 N_4 N_3.	....	8 02	14 22	13 10	6 20	6 50	0 03	? 0 58	0.30	0.47	0.17	0.22	....	....	E. by N.	W	18	W'n portion Sandy Hook bay.

NOTE.—The minus sign is used to indicate that slack current precedes the stand of the tide.

APPENDIX No. 28.

Report of Assistant H. Mitchell, on the investigation of currents in the East river, at Hell Gate and Throg's Neck, the sub-currents of New York bay and harbor, and levelings on the banks of the Hudson river.

BOSTON, *October* 20, 1858.

DEAR SIR: I would respectfully announce to you the closing of our season's field-work upon the physical survey of New York harbor and approaches, and beg leave to submit the following abstract of our labors, which have been prosecuted in accordance with your instructions. The work is necessarily left incomplete, as anticipated from the insufficient appropriation afforded; but, favored by a remarkably fine season, we have accomplished more than we could have expected. I shall proceed to state the progress we have made on the different portions of the work, in the order in which they were taken up.

HELL GATE.

The computation of the results from the physical examination of Hell Gate, undertaken last year, gave, with a single exception, the most satisfactory evidences of the accuracy of the observations, and this exceptional case was rendered doubtful by the contradictory character of the observations, made under difficulties almost insurmountable. I allude here to the results for the maximum velocity of the flood current off Hallet's Point. In this locality you will recollect the flood streams are gathered together into a single torrent, in which no boat can lie at anchor. We repeatedly tried, last year, to secure a boat in this place during the flood current, and in each case it was either run over by drifting vessels or by the stream itself. Abandoning this plan at last, as a vain risk of life, we attempted to ascertain the facts by following free floats and noting the time of their passage across certain ranges. Many experiments of this kind were made with varying results, but since each float chose a distinct path we could not feel authorized to take a mean of the velocities given. In view of these discrepancies it was determined to try again, this year, a series of similar experiments. The plan we adopted was as follows: Three fixed points were chosen—Cram's Dock, Negro Point, and Hallet's Point—at which observers were stationed, each provided with a chronometer and sextant. A fourth person crossed and re-crossed upon the ferry boat which plies between Astoria and Eighty-sixth street, throwing over floats as he passed certain ranges previously designated, and at the same time giving a signal to apprise the observers on shore. The observers at their stations then recorded every change of position in the floats, however slight, with the exact moment of time at which it occurred. In this way the movements of seven or eight floats were ascertained and their journeys plotted out. Our experience has always shown that all methods of observing currents other than that by the use of the common log and line, from fixed stations, are subject to peculiar objections; and it is only in cases like that above mentioned that we have departed from the old plan. We have thought it necessary to be the more careful to collect all the details in our examination of Hell Gate, in view of future wants. Should any of the desirable improvements of this tortuous passage ever be undertaken it will be easy, by repeating these experiments and comparing the results with our present elaborate series, to ascertain the changes in the character of the tidal streams which may result from the removal of rocks or from the erection of artificial structures in the water.

VICINITY OF THROG'S NECK.

In connection with our work of last year in Hell Gate we occupied a few stations further to the eastward, in order to extend our series to the western entrance of Long Island Sound; and from these few observations it became apparent that a more detailed examination was necessary over a portion of this space. Such an examination has formed a part of this season's operations.

To those familiar with the navigation of Long Island Sound it is well known that in the vicinity of Throg's Neck occur abrupt transitions both in the epochs and directions of the tidal currents. To the eastward the currents of Long Island Sound are normal in character and result from the disturbances of sea level caused by the delays and changes of the single branch of the tide wave which traverses the Sound in a westerly direction; while to the westward the currents of Hell Gate are called into action by the interference of two essentially distinct branches of the tide wave, the wave from the Sound meeting that from Sandy Hook.

Along the path of the Sound wave the changes of epoch and range have been gradual from point to point, and the currents are consequently steady, but not rapid. On the other hand, the interference at the narrow pass in Hell Gate is so direct that at certain intervals the contrast of heights upon either side is great, and the most violent currents are unable to restore the water level.

Although it may be stated generally that the meeting and dividing place of these two systems of currents lies in the neighborhood of Throg's Neck, it can by no means be laid down as a fixed point upon the chart; for it shifts its position continually, in a manner that has hitherto defied calculation. It thus occurs that, throughout a considerable district, the epochs are subject to changes of several hours, not only from one day to another, but even from one tide to the next. Regarding these changes as the effects, however indirect, of the daily and half monthly inequalities in the tide waves, we have felt confident that a careful study would detect a law of recurrence among them. In accordance with this view of the subject, our observations have been made not only to embrace all the phenomena exhibited at various points, but to cover also a sufficient period of time for a repetition of some of the tidal phases; and we may venture to state that we have been so far successful that we hope, on grouping our results, to be able to furnish the intelligent navigator with a simple and direct rule by which he can find at what periods the flood current of the Sound will pass to the westward, or that of the Gate to the eastward, of the mean limits, and the distance to which either may extend. In undertaking this investigation we were occupied night and day more than two weeks, during a period of almost uninterrupted good weather. Divisions of the party worked at two, and frequently at three stations, simultaneously, and above two thousand observations were recorded. The region covered by this work extends from Hell Gate to Sands' Point.

I will mention, in this connection, that while occupying our more easterly stations we made a series of soundings in the channels off Execution rocks, and compared our results with the Coast Survey chart. Over a limited extent we found that some changes had taken place during the twenty years that have elapsed since the former survey under the superintendence of Mr. Hassler. A portion of these changes we ascertained to be artificial, and caused by the removal of oyster beds; others could only have been the result of such natural causes, as the scouring action of the tidal and other currents.

NEW YORK BAR AND HARBOR.

The operations above described formed but an incidental portion of the season's field-work; the main project directed by your instructions being a physical examination of the bar, together with the channels and shoals of the upper and lower harbors, on the plan of the Sandy Hook investigation of 1856.

It may be remarked of the shoals and beaches in the harbor of New York, that they are composed for the most part of yielding materials; that they have constantly shifted their positions and enlarged or decreased their areas since the earliest record; and yet, through all these mutations, they have preserved certain characteristic and type forms that have seemed to us to indicate that their existence and preservation are alike due to the action of constant or periodical forces, certain in their operation, and not inconsiderable in power. Among these natural activities, it is evident that the pluvial and tidal currents take primary parts; they bring down to the coast abundant materials, and finally deposit them according to complex but invariable laws. Nor is it difficult to distinguish the immediate operations of these ever renewed and busy agents from the more violent effects of storms, since the former repeat themselves in forms that have become familiar to the close observer under similar conditions everywhere, while the latter present only local peculiarities. We have met at each step in the harbor of New York with deposits to be recognized at once as belonging to determined classes, whose modes of formation and whose histories have been, at least in part, ascertained in our former investigations elsewhere. The currents, therefore, have been regarded as the chief subjects of study, and the means which you have placed in our hands we have devoted to this end. At the outset we divided our party so as to occupy at once several stations along the main avenues of the currents, in order to ascertain the nature of the streams in a general manner, and their relative movements. Subsequently, however, we took up limited sections in the closest possible detail, making each shoal and each channel a special study. In this way we designed to make each step complete, and be able at any time, in the event of insufficiency of funds, to postpone our work without injury of the portion already accomplished. In thus separately studying each formation, we have not omitted to trace their connection, and to perceive that the work of one stream may induce or necessitate a subsidiary work by another. The shoals, for instance, formed by the ebb stream in many instances, by opposing the path of the flood, cause the latter to scour out peculiar channels, or cast down deposits forming peculiar shoals. The fresh water streams in some localities serve only to supply materials with which the more powerful tidal drifts may build, while in others they themselves take the part of constructors. The data which we have collected will, I think, exhibit these natural operations in all possible simplicity. We have, for this work, occupied above thirty stations, remaining at them in some cases from seven to ten days, and continuing the observations day and night. At these stations every change in the current, whether of direction or velocity, has been noted with the utmost care; and in addition to this the periodical appearances of rips and eddies, as well as many other details, have been recorded. The field which this work is designed to cover extends from the city of New York over the upper and lower bays, and some ten miles to the eastward of the bar.

Until the past season our observations have been confined to surface currents only; but your instructions having insisted that we should also study the motions of the water below, we have taken especial pains to comply with your wishes, and by simple apparatus have obtained many desirable results. We ascertained that, instead of uniform gradation of velocities from surface to bottom, there often occurs in deep channels a counter drift, or even distinct streams, at different depths. These singular movements were ascertained to belong to certain localities only in New York harbor, where they assume sometimes the forms of immense rotatory movements in vertical planes. At some of our stations phenomena of this character never fail to repeat themselves daily, on the recurrence of certain tidal phases, while at others the wind enters in as an element and varies the conditions. At certain stations we found that when the surface current is opposed by strong winds the axis of the stream sinks, and the water pours on below the retarded stratum as beneath a sluice. I mention these points to show with what variety this single inquiry abounds, and to suggest that many new conclusions are likely to follow your study of the data we have collected. From the most hasty consideration of our results it may be seen that, without a knowledge of these sub-currents, structures, however simple, placed in New York harbor, may be productive of the most disastrous consequences, by controlling in a degree the future movements of the shoals, or by causing new deposits.

HUDSON RIVER.

That portion of the work in the Hudson river left unfinished from former seasons has now been completed. The results are satisfactory, although the work was not at the outset as elaborately undertaken as might have been wished. I think you will perceive, from an inspection of the results, that the means afforded to us have been carefully applied. Mr. G. B. Vose has devoted himself especially to this work, and pushed it forward with characteristic energy.

I cannot conclude this imperfect sketch of the season's work without acknowledging my indebtedness to my assistant, Mr. W. H. Gardner, and aid upon the Coast Survey, and Mr. J. W. Donn, who acted temporarily in the same capacity. Mr. Swain and Mr. Donegan, of whom I have frequently spoken to you, made many of the most careful observations, and in their work I have placed great reliance.

Very respectfully, yours,

H. MITCHELL,
Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 29.

Report to the Superintendent by Assistant L. F. Pourtales, in charge of the field and office-work relating to tidal observations.

COAST SURVEY OFFICE, *October* 1, 1858.

SIR: I have the honor to submit the following report on the field and office-work performed during the past year by the tidal party under my charge.

FIELD-WORK.—As explained in former reports, the stations at which tides are observed are distinguished as permanent and temporary. Of the former there are five on the Atlantic Coast, viz: Boston, New York, Old Point Comfort, Va., Charleston, S. C., and Fort Clinch, Fla.; and three on the Pacific Coast: San Francisco, San Diego, and Astoria.

The Boston series extends now over more than eleven years, during which time no more than half a dozen tides were lost. At this station the observations are made on a common gauge, established against the wall of the dry dock at the Charlestown Navy Yard, by the observer noting the time and height of high and low water. At all the other permanent stations self-registering tide-gauges are used. At New York, however, a box-gauge is used during the winter, on account of the frequent interruptions to which the self-registering tide-gauge was exposed by freezing. The gauges at Old Point Comfort, and Fort Point, San Francisco, have been re-established on more solid foundations during the year.

The temporary stations have not been very numerous. A self-registering tide-gauge was established, with permission of the Secretary of the Navy, at the Washington Navy Yard. It is attended to by the officers in charge of the ordnance department of the yard. The four stations established by Mr. Würdemann along the Florida reef, and mentioned in last year's report, were kept up for a little more than a year with complete success. The three gauges used at Cape Florida, Indian key and Key West were then transferred by your direction to Charlotte harbor, Egmont key and Cedar Keys, and the station at Tortugas continued as a connecting link between the two series.

Interesting self-registering observations were made under the direction of Lieut. R. M. Cuyler, U. S. N., at several points in San Francisco bay, in order to obtain fuller data for the study of the changes which the tide-wave undergoes after entering the bay, as had been indicated by less extended observations previously made in the same waters. Observations were also made under the same direction at Sacramento City, with the object of studying the changes which the daily inequality might undergo in following a long and confined channel. A series of observations were also received from the same party from Semiahmoo bay, near the northwestern boundary.

A list of all the observations received during the year is appended in tabular form.

List of tidal observations received during the year ending September 30, 1858.

Sections.	Name of station.	Name of observer.	Kind of gauge.	Station, permanent or temporary.	Time of occupation. From—	Time of occupation. To—	Total days.	Remarks.
I.	Boston dry dock, Mass.	T. E. Ready.	Staff	Permanent	Oct. 1, 1857	Sept. 30, 1858	365	
	Menemsha Bight, Mass	B. F. Pease	Box	Temporary	July 1, 1857	Aug. 19, 1857	50	
	No Man's Land, Mass.	Swain & Valentine	do	do	July 7, 1857	do	44	
II.	Governor's Island, N. Y.	R. T. Bassett	S. R*	Permanent	Oct. 1, 1857	Dec. 28, 1857	89	Observations made at Brooklyn during the cold weather.
	do	do	do	do	Ap'l 16, 1858	Sept. 30, 1858	168	
	Brooklyn, N. Y	do	Box	do	Oct. 1, 1857	do	365	Only day observations in summer.
	Sandy Hook, N. J.	A. P. Springer	do	Temporary	do	Jan. 10, 1858	102	
	Greenbush, N. Y.	C. Richardson	S. R.	do	Sept. 1, 1857	Dec. 22, 1857	83	Record for October lost by freshet.
III.	Old Point Comfort, Va	M. C. King	do	Permanent	Oct. 1, 1857	Sept. 30, 1858	365	
	Washington navy yard, D. C.	Lieut. A. Pendergrast	do	Temporary	Ap'l 27, 1858	do	157	
V.	Charleston, S. C.	W. R. Herron	do	Permanent	Oct. 1, 1857	do	365	
VI.	Fort Clinch, Fla	F. A. Rebarer	do	do	do	do	365	
	Cape Florida, Fla	C. Keyser	do	Temporary	Aug. 6, 1857	June 10, 1858	309	
	Indian key, Fla	W. A. Bethel	do	do	Aug. 25, 1857	June 15, 1858	295	
	Key West, Fla	J. C. Clapp	do	do	Sept. 1, 1857	June 1, 1858	273	
	Tortugas, Fla	H. Benners	do	do	do	Aug. 1, 1858	335	
	Charlotte Harbor, Fla	G. W. Maslin	do	do	July 3, 1858	Aug. 3, 1858	31	
	Egmont key, Fla	C. Keyser	do	do	July 22, 1858	Aug. 22, 1858	31	
X.	San Diego, Cal.	A. Cassidy	do	Permanent	Aug. 1, 1857	July 31, 1858	365	
	Fort Point, Cal	H. E. Uhrlandt	do	do	do	do	365	
	Ravenswood, Cal	J. S. McIntire	do	Temporary	Mar. 3, 1858	June 4, 1858	93	
	Mare Island, Cal.	do.	do	do	Oct. 21, 1857	Feb. 26, 1858	129	
	Sacramento, Cal.	Lieut. R. M. Cuyler	Box	do	Nov. 11, 1857	Nov. 29, 1857	19	
XI.	Astoria, Oregon	J. Wayne	S. R.	Permanent	Aug. 1, 1857	July 31, 1858	365	
	Semiahmoo, W. T.	Lieut. R. M. Cuyler	Box	Temporary	July 20, 1857	Sept. 17, 1857	60	

* Self-registering tide-gauge.

OFFICE-WORK.—The party in the office has been rather smaller than in previous years, so that at times the reductions have kept considerably behind the observations. They are, however, nearly up with them now, but as they have been made by many different persons, mostly beginners, they want a systematic revision before they can be safely used. I have taken steps to have that work done as early as possible, and have, in fact, already made a beginning.

The ordinary reductions were made by G. C. Blanchard, R. E. Evans and S. D. Pendleton. The readings from the sheets of the self-registering tide-gauges were made by R. E. Evans for part of the year, but principally by S. Walker; those for the Western Coast, as usual, by Sergeant H. E. Uhrlandt, at San Francisco.

The discussion of observations, with the view of obtaining tables for predictions, has been continued by Messrs. Meech and Avery. The latter has computed coefficients from the Boston observations, which appear promising. He is now engaged in investigating their range of variation from year to year. He was for a time assisted by Mr. D. Trueheart.

Decompositions by the graphical method of the curves of observation at the four stations along the Florida reef into the diurnal and semi-diurnal waves were begun by Mr. S. Walker, and continued by Mr. J. Downes. It is a work requiring much patience, but which will certainly repay in the end.

The discussion of the meteorological observations of the Western Coast has been continued by M. Thomas. Curves have been drawn representing the hourly variations of the barometer, thermometer, and psychrometer. The state of the barometer, under the influence of the different winds, has also been studied and illustrated by diagrams.

Very respectfully, your obedient servant,

L. F. POURTALES,

Assist. U. S. Coast Survey in charge of Tidal Division.

Prof. A. D. BACHE, LL.D.

Superintendent U. S. Coast Survey.

APPENDIX No. 30.

The co-tidal lines of an enclosed sea, derived from the equilibrium theory. By Professor Benjamin Peirce.

The theory of the oceanic tides is practically an unsolved problem, and will require much laborious groping before it can be elucidated. The following investigation probably belongs to that negative class, which may assist in arriving at the positive result, but is destined to be forgotten when that result is reached.

There is no closed sea of sufficient magnitude to have any interest in regard to its tides. But the North Atlantic ocean is a sufficient approximation to such a sea to deserve a special inquiry as to the nature of the tides with which it would be affected if it were strictly closed, while the rest of the ocean may be regarded as another closed sea, of which the South Atlantic and the Indian ocean are two mighty bays, but which is so vast as greatly to modify the tidal laws derived from the equilibrium theory. I propose then, in the following inquiry, to consider

I. The general theory of the co-tidal lines in an enclosed sea, derived from the equilibrium theory.

II. The modification of this theory by the incompleteness of the enclosure.

III. The application to the North Atlantic.

IV. The application to the Pacific.

I. *The general theory of the co-tidal lines in an enclosed sea, derived from the equilibrium theory.*

The investigation of the co-tidal lines on the equilibrium theory is not materially affected by the absolute mass of the moon, and in a first approximation the action of the elevated water may be neglected, especially when it is considered that the computations of this theory are made for the purpose of suggesting the true laws of the phenomena.

On the usual principles of the equilibrium theory, *the surface of the water becomes level at a certain constant interval after the instant to which it properly belongs.* This interval of delay may be assumed to be not far from six hours. If, then,

η denotes the angular geocentric distance of a point P of the ocean from that position of the moon which corresponds to the surface of level, the elevation of the water at P may be expressed by the formula—

$$y = \text{A} \cos.^2 \eta + \text{B}.$$

The quantity A of this formula is a constant which is proportional to the mass of the moon, while B is a constant which is to be determined at each instant by the condition that the aggregate elevation of the water of an enclosed sea vanishes, or is nothing. If

$d\sigma$ is an element of the surface of the sea the equation for the determination of B is

$$B = -A \int_\sigma \cos.^2 \eta.$$

If, moreover,

$\lambda =$ the longitude of P,

$\theta =$ its latitude,

$t =$ the sidereal time for the zero of longitude, which corresponds to the position of level surface,

$\alpha =$ the moon's right ascension,

$\beta =$ the moon's declination,

the values of η and $d\sigma$ are given by the equations

$$\cos.\ \eta = \sin.\ \theta \sin.\ \beta + \cos.\ \theta \cos.\ \beta \cos(\alpha + t - \lambda),$$

$$d\sigma = \cos.\ \theta\, d\theta\, d\lambda.$$

These equations give

$$\cos.^2 \eta = \sin.^2 \theta \sin.^2 \beta + \tfrac{1}{2} \cos.^2 \theta \cos.^2 \beta + 2 \sin.\ \theta \cos.\ \theta \sin.\ \beta \cos.\ \beta \cos.\ (\alpha + t - \lambda) + \tfrac{1}{2} \cos.^2 \theta \cos.^2 \beta \cos.\ 2\ (\alpha + t - \lambda);$$

So that, if

$$L = \sin.^2 \theta \sin.^2 \beta + \tfrac{1}{2} \cos.^2 \theta \cos.^2 \beta,$$

$$M = 2 \sin.\ \theta \cos.\ \theta \sin.\ \beta \cos.\ \beta,$$

$$N = \tfrac{1}{2} \cos.^2 \theta \cos.^2 \beta;$$

$$L_0 = \int_\sigma L,$$

$$M_0 \cos.\ \mu = \int_\sigma (M \cos.\ \lambda),$$

$$M_0 \sin.\ \mu = \int_\sigma (M \sin.\ \lambda),$$

$$N_0 \cos.\ 2\nu = \int_\sigma (N \cos.\ 2\lambda),$$

$$N_0 \sin.\ 2\nu = \int_\sigma (N \sin.\ 2\lambda);$$

the expression for the height of the tide assumes the form—

$$\begin{aligned} \frac{y}{A} &= L - L_0 + M \cos.\ (\alpha + t - \lambda) - M_0 \cos.\ (\alpha + t - \mu) \\ &\qquad + N \cos.\ 2\ (\alpha + t - \lambda) - N_0 \cos.\ 2\ (\alpha + t - \nu) \\ &= L - L_0 + P \cos.\ (\alpha + t - \lambda_0) + Q \cos.\ 2\ (\alpha + t - \lambda_1), \end{aligned}$$

in which

$$M \cos.\ \lambda - M_0 \cos.\ \mu = P \cos.\ \lambda_0,$$

$$M \sin.\ \lambda - M_0 \sin.\ \mu = P \sin.\ \lambda_0,$$

$$N \cos.\ 2\lambda - N_0 \cos.\ 2\nu = Q \cos.\ 2\lambda_1,$$

$$N \sin.\ 2\lambda - N_0 \sin.\ 2\nu = Q \sin.\ 2\lambda_1.$$

The instant of high water is consequently given by the equation

$$\sin.\ \varepsilon = \tan.\ \beta,$$

$$\cot.\ \eta = \cos.\ \alpha.$$

The least value of the major axis corresponds to

$$t = \nu + 3^h,$$

when

$$\alpha = \theta_0.$$

The values of N_0 and ν are determined in special cases by the algebraic decomposition of the given ocean into spherical right triangles, of which it is the algebraic sum; and in each of which the legs are the equator and a meridian. If, for either of these triangles,

$\lambda' =$ the longitude of the meridional leg,

$\theta' =$ its length,

$\lambda'' =$ the length of the equatorial leg,

$i =$ the angle of the triangle, which is opposite the meridian,

the corresponding portions of N_0 cos. 2ν and N_0 sin. 2ν are derived from the formulæ

$$2\,N_0 \cos.\, 2\,(\nu - \lambda' + \lambda'') = \textstyle\int_\sigma [\cos.^3 \theta \cos.\, 2\,(\lambda - \lambda' + \lambda'')]$$
$$= \tfrac{1}{2} \textstyle\int_\theta [\cos.^3 \theta \sin.\, 2\,(\lambda - \lambda' + \lambda'')]$$
$$= \tfrac{1}{6} \sin.\, 2\,i\,[1 - \cos.^3 \theta' \cos.^3 (\lambda - \lambda' + \lambda'')],$$

$$P \sin.\, (\alpha + t - \lambda_0) + 2\,Q \sin.\, 2\,(\alpha + t - \lambda_1) = o$$

and this is also the equation of co-tidal lines for any instant t.

The first approximation to the actual mean co-tidal lines is determined for the case in which the moon is in the equator; in which case

$$\alpha = \beta = o\,,$$
$$M = M_0 = P = o\,;$$

so that the equation of the co-tidal line is reduced to

$$Q \sin.\, 2\,(t - \lambda_1) = o\,;$$

or

$$N \sin.\, 2\,(t - \lambda) = N_0 \sin.\, 2\,(t - \nu).$$

This equation is satisfied, without regard to the value of t, by the point which corresponds to the equations

$$\lambda = \nu,$$
$$N = N_0 = \tfrac{1}{2} \cos.^2 \theta_0\,,$$

so that *there is no tide for this point, and every co-tidal line passes through it.* Its latitude is θ_0 and its longitude is ν.

The equation is also satisfied by the values

$$t = \lambda = \nu = o,$$

so that *the meridian which passes through the point of no-tide is one of the co-tidal lines.*

The equation is also satisfied by the values

$$N = N_0$$
$$\lambda = 2\,t - \nu - 6^h$$

so that *the intersection of the co-tidal curve with the circle of latitude, which passes through the point of no-tide, increases in longitude at double the rate of the increase of the hour angle.*

If the equation of the co-tidal curve is written in the form

$$\text{Cos.}^2\,(\lambda - t + \tfrac{1}{4}\pi) - \sin.^2\,(\lambda - t + \tfrac{1}{4}\pi) = \cos.^2 \theta_0 \sin.\, 2\,(t - \nu) \sec.^2 \theta,$$

in which π is the ratio of the circumference to the diameter, *this curve is obviously a spherical ellipse, of which the centre lies upon the equator in the longitude $t - 3^h$, or it may be regarded as a spherical equilateral hyperbola of which the earth's pole is the centre, so that the cyclic arcs are the perpendicular meridians of which the longitudes are t and $t - 6^h$.*

The major axis (α), the minor axis (β), the angle of eccentricity (η), and the latitude (ϵ), of the focus of the ellipse are determined of the equations.

$$\text{Cos. } 2\,\beta = \cos.^2 \alpha = 2\,N_0 \sin. 2\,(t - \nu) = \cos.^2 \theta_0 \sin. 2\,(t - \nu),$$

$$2 \sin.^2 \beta = \sin.^2 \alpha,$$

$$2\,N_0 \sin. 2\,(\nu - \lambda' + \lambda'') = \textstyle\int_c [\cos.^3 \theta \sin. 2\,(\lambda - \lambda' + \lambda'')].$$

$$= \textstyle\int_\theta [\cos.^3 \theta \sin.^2\,(\lambda - \lambda' + \lambda'')].$$

$$= \tfrac{1}{3} \cot.^2 i \sin.^3 \theta'.$$

The algebraic sum of all the portions of $N_0 \cos. 2\,\nu$ and $N_0 \sin. 2\,\nu$ gives their complete values, from which N_0 and ν are readily computed. The general value of ν for any declination of the moon is the same with its special value, whereas the general value of N_0 is obtained from the special value by multiplying by $\cos.^2 \beta$. But this portion of the subject is reserved to a special investigation of the influence of the moon's declination.

II. *The modification of the theory of the preceding section by the incompleteness of the inclosure.*

The incompleteness of the inclosure affects the tides in two ways: first, by the admission of water, which causes a general and simultaneous fluctuation of the whole surface of the imperfectly closed ocean, or secondly, by special fluctuations, which vary with the various positions in the ocean.

First. The general fluctuation will only cause a modification of the value of B, and will leave it uncertain, as well as the position of no-tide.

Secondly. The special fluctuations will cause local deviations from the general law of the tide, which will probably be magnified in proportion to the distance of the place from the open channel.

The analysis of the actual phenomena so as to separate these two classes of effect cannot be difficult, if this form of the equilibrium theory should prove to have any claims to be regarded as an approximation to the true theory, and must lead to much interesting and valuable discussion.

APPENDIX No. 31.

On the dynamics of ocean currents. By Lieut. E. B. Hunt, Corps of Engineers, U. S. A.

It can scarcely be denied that the state of our knowledge of ocean currents is anything but satisfactory. Not only are we to a very great extent ignorant of the precise state of the facts but we are also deficient in the theoretical exposition of those already known. We can easily explain our lack of precise knowledge of facts by reference to the circumstances. The vast oceanic areas can only be observed by persons engaged in navigation who are mostly unfurnished with proper means for correct determinations, and who lack that special training which is a prime essential for good observations. The facts to be observed are also of such a complex and elusive character, are so subject to fluctuation in a given locality, and are involved in movements of air and water of such vast compass, that we cannot hope for precision of knowledge by the use of means now in operation. The single fact that most observations are made on the water surface while the ocean depths are of vital efficacy in shaping all marine phenomena, gives a signal character of incompleteness to those observations which have been mainly instrumental in fixing the received notions on the system of oceanic circulation. It is a fit subject of regret, that the discussion of ocean movements has been so rarely attempted by those whose previous training in mathematical and mechanical science would have been an effectual guaranty and preventive against the wild and illogical rhapsodies of the too numerous theorists who have run riot over the broad domain of the physics of the sea.

With a view to apprehending the mechanical elements of this problem of ocean currents, let us first suppose a terrestrial sphere which has assumed the equilibrium condition resulting from gravitation, diurnal rotation, a solid nucleus and a homogeneous water envelope unbroken by land. This water stratum would shape itself so that its bounding surface would be a strict mathematical level surface. A level surface of this nature may be defined as one which is at each point perpendicular to the resultant of all the forces acting on the individual molecules situated in that surface. In this case it would be a continuous oblate spheroid, to which the resultant of gravity and centrifugal force is everywhere normal. If to these we add those diurnal disturbances of the normal level due to the inequalities of solar and lunar attraction during the earth's rotation, we obtain the tidal waves which appear as perturbations of the normal level. If the continental masses be supposed to be elevated, we have a slightly modified normal level surface for the ocean, but one which once determined becomes the proper standard of reference for all oceanic perturbations, to whatever cause due. This surface is everywhere the true bounding surface and cuts the resultant of mean gravity and centrifugal action for the earth *as it is*, perpendicularly at each point of the surface, and is entirely continuous, though no more truly spheroidal. This is the normal ocean level, and it is a useful surface of reference for all vertical ocean movements or perturbations.

If we now suppose the homogeneous earth without continents subjected to the heating action of the sun's rays, the result will be that the equator will become a line of maximum heating, from which to the poles there will be a progressive diminution of heat absorption. This would cause an expansion of the heated waters which would thus rise above the normal level surface by an amount equal to the expansion at each point. Thus, from the pole to the equator a spheroidal meniscus would be spread equal to the ocean expansion under the solar heat. It is a remarkable feature that the heating leaves each vertical ocean column of its original weight and there is thus a perfect mechanical equilibrium between these columns considered as joined by their interior bases. Thus considering the grand ocean masses, there is no disturbance of static stability from the heating agency of the sun, and hence there is no formation of massive currents due to this cause.

If, now, we regard the heated ocean in its hydrodynamic aspect, we find that the bounding surface having everywhere a slope towards the pole exceeding that of the normal level surface, there remains an unresisted surface tendency towards the pole which primarily tends to produce a superficial flow from the equator polewards. This is manifestly but a slight disturbance of normal level amounting in the meridian quadrant only to the vertical expansion at the equator and being diffused over the entire quadrant. It is extremely doubtful if this would suffice to overcome the passive resistances and produce an actual surface overflow. If, however, a current were once established by any other agency, as the wind, the equatorial heating would constantly operate to maintain this current. The heated water would constantly be lifted as a floating mass on the colder waters, which, pushing on the lighter equatorial mass at its base, would come in to replace any deficiency of mass due to the superficial outflow. Taking the facts as they are, we find in the trade-winds and the resistance of the continents two causes fully adequate to break up the static equilibrium referred to, and obviously giving the precise direction to the outflow which it actually has. Thus, while the type of action induced by the solar heating power considered along the meridian is surface outflow and deep inflow, the perennial trades determine this circulation along a different and constant route, fixed first by continental obstructions and essentially modified in direction by the earth's rotation.

As the equatorial evaporation greatly exceeds the corresponding rain fall, this operates to counteract, in part, the regular outflow by diminishing the quantity of water to be discharged on account of expansion due to heating. This would also increase the saltness and specific gravity of the equatorial waters, and to that extent would bring their actual surface into closer accordance with the normal level. It is clear that this saltness could not fully compensate for the expansion by heating, or we should have the surface reduced to the normal level, when all would either be in stable equilibrium or below it, when the currents would be reversed.

It thus appears that the expansion due to equatorial heats induces a superficial derangement tending to overflow towards the poles, which, by the trade-winds and continents, is determined to a single line of debouche. This gives a discharge with far less frictional resistance than a direct meridional outflow would encounter, as this would involve a polar set for the entire ocean surface.

Accepting the well determined trade-winds and the equatorial current as certain facts, we shall find that the vast surface sheet of water which has a westerly set under the trades, having acquired a very considerable velocity, becomes the representative of a vast amount of living force. When by impact against western barriers this vast sheet of water undergoes inflection to the north or south, it still retains the greater portion of its living force, and will continue to do so until this is wholly expended in overcoming resistances. If, now, we bear in mind that the wide equatorial sheet is by this deflection consolidated into a compact current of deep section, and also that the resistance per mile is proportional to the length of the line of frictional resistance in a cross section, we shall see that the currents turn towards the poles with their forward impulse almost unabated, and with the resistances greatly reduced. We ought, therefore, to expect that the inertia of this vast moving mass would suffice to carry it on, with a mean velocity slowly abating, to the polar regions. So soon as the progress of the current gives it an increasing latitude, the effect of the diminishing parallels, in giving an eastward trend, would show itself, and, combined with the forward projectile motion of the mass of waters, would determine the route of the current, governed, of course, by solid opposing masses of continents, islands, and shoals.

Reaching the Arctic neighborhood, this current would fall in with the tendency to restore to the equatorial region the waters withdrawn by outflow, and which thus leave a deficiency of static mass in that region. Its forward force not yet expended would bring it into the equatorial flow only after a long Arctic sweep. Then, bounded in by the eastern ocean borders, it circles on to the equatorial belt, there to start the repetition of its course either directly or by proxy, if entering at great depths it serve only to lift higher portions above the normal level.

We have thus a continuous circuit in which the water whirls under the primary impulse derived in the equatorial region from an outflow due to heating and the direct propulsion of the trade-winds. The primary order of circulation is in two currents, the upper running polewards and the under from the poles to the equator. This order is entirely modified by the action of the trades, and becomes essentially a horizontal circulation, the propelling action of these perennial winds conspiring with the outflowing declivity to determine an immense movement of which the living force, imparted in the equatorial region, suffices to carry on the circuit in full and enduring activity.

This consideration of the effect of inertia in storing the living force of this immense equatorial current, and thus enabling it to sweep through the cycles of the seas, has not been duly considered. These currents, in such a place as Florida straits, move in a closed channel, and are subject to the hydrodynamic rules for this case. The gradual changes of direction and velocity there imposed produce less absolute resistance than is generally imagined, by reason of the great mass of waters relative to the area of frictional surfaces.

The problem of ocean currents is of very great complexity, not only on account of the difficult hydrodynamic questions involved, but because the effects of the winds on the ocean surface can scarcely be subjected to estimation. The permanent elevation of the equatorial waters above the normal level, traced from the pole, might be approximately determined by knowing the mean equatorial ocean temperature at all depths, and the same from point to point towards the pole, accompanied with observations on the corresponding saltness. Were there a considerable deficiency of weight in the vertical equatorial column relative to an Arctic one connected by their bases at the same deep level, this would at once generate a compensating wave towards the equator. As we may be sure that the equatorial mean ocean temperature exceeds the Arctic mean temperatures, we must concede *some* elevation above the true normal level throughout all the warmer latitudes, but any attempt to definitely fix its amount would be very rash in the present state of our knowledge.

There are numerous secondary points which might enter this discussion, but which need not now be considered. I will notice a slight oceanic oscillation, which is practically unimportant, but which I believe has not before been noticed. The sun, in its daily round, must heat the waters of the sea at a given locality in such a manner that there shall be a daily maximum and minimum sea temperature due to absorption and radiation combined. This must give a maximum and minimum of expansion, or a species of tidal wave would follow the sun, which might well be called the heliothermal tide. It would clearly be too minute for separate observation, and, though curious, cannot be important.

Another circumstance is worthy of notice here: A forward current in the sea has a distinct bounding surface, on which it encounters a frictional resistance. The mode in which this resistance is expended is by a constant dragging into the forward movement parts of the layer of water making the boundary of the current. Thus, if a current be moving through a sea otherwise tranquil, it will, by this lateral dragging, carry forward such a volume of water in addition to its own proper mass that a counter current must set in to restore the level. This is, I suppose, the explanation of some of the counter currents which exist along the great oceanic currents, as also of the eddy currents of rivers, &c.

These two imperfect generalizations may do something towards making the system of ocean currents more comprehensible. So great a subject needs treatment far different from what it has yet received, and, first of all, the essential facts should be more clearly established. Unfortunately, this can only result from long well organized and costly operations for this express purpose. We must be content to do our several small parts patiently, hoping for more light in the future.

APPENDIX No. 32.

On some anomalies in the Florida Gulf Stream, and on their further investigation. By Lieut. E. B. Hunt, Corps of Engineers, U. S. A.

There is perhaps no portion of the ocean waters which has been so imperfectly studied, in proportion to its importance, as that from the west end of Cuba through the Gulf of Florida. The whole commerce of the Gulf of Mexico is directly concerned in whatever investigations shall more accurately define the currents, and other physical peculiarities, of that portion of the Gulf Stream area from the line joining Cape Antonio with Cape Catoche, and the latter with the Tortugas; thence to the eastward, through that grand channel bounded on the north and west by the Florida reef and mainland, and on the south and east by Cuba and the Bahama banks. As being the natural outlet for the products of the entire Gulf coast and of the valley of the Mississippi, the present commerce following this route, vast as it is, must ultimately be so far exceeded that it will seem almost insignificant in comparison with that which another half century will direct through this channel. The character of this navigation, not less than its amount, is such as to demand the most careful study of the currents by which it is so largely influenced. All are so familiar with the immense annual losses to commerce by wrecks or disasters on the Florida reefs and Bahama banks, that a simple reference to the fact will abundantly indicate the importance of carefully gathering whatever knowledge can give greater safety to this navigation. The high extra premiums for marine insurance by the Florida channel route afford another striking testimony to the risks of this navigation; but I think it right to remark here, that from the best information I could procure at Key West the Florida channel insurance rates are very much too high, and are annually giving exorbitant profits to the insurance companies. This makes it the interest of these companies to exaggerate the dangers of this passage, and it is believed that they are on this account less averse to wrecks and less strict in distinguishing collusive or fraudulent wrecks than they should be. A reduction of rates must soon be made, if we may judge from the fact that owners are to a considerable extent becoming their own insurers in preference to paying the established rates. The new light-houses and Coast Survey beacons have added much to the security of this route, and the business of wrecking at Key West is on the whole diminishing, although commerce is, of course, increasing. Making all due abatement for exaggerations of the terrors of the Florida straits, and for the increased aids to navigation, there still remains a very serious annual marine loss, due almost entirely to the imperfect acquaintance of navigators with the peculiarities of the route, and especially with the currents. Misled by false or imperfect views about the Gulf Stream and other currents prevailing here, sea captains are frequently so unfortunate as to run directly on the reefs, while they suppose they are well out in the channel way. I cannot but think that a system of reef pilotage, properly organized and well conducted, would lead to a great reduction in the number of casualties. By taking and leaving well-trained pilots at the entrance to and exit from the region of danger, the numerous casualties due to the imperfect knowledge of sea captains would be in great part obviated. Skilful pilots constantly engaged in taking vessels through the channel would grow more and more certain of all the essentials for secure passages, until it would become a gross offence to lose a vessel except from causes truly extraordinary. It is obvious that such pilots should be so situated that no possible advantage could accrue to them in case of wreck, while a premium should be awarded for each safe pilotage. Were such a system in full operation, it would be a proper rule that a vessel failing to take a reef pilot should forfeit its insurance, except when no pilot could be procured. A great difficulty in accomplishing this plan, except by the combined action of the insurance companies, is found in the fact that three national jurisdictions enter the field of pilotage.

A first essential for giving greater security to the Florida channel navigation is a more correct determination of the currents by which vessels are affected during the transit. Having spent the last winter at Key West, I was led to inquire about these currents with some particularity, and as a result was brought to the opinion that the prevalent views are very seriously at fault. There are many facts quite incompatible with the common notions of a vast current constantly sweeping around the Gulf of Mexico, and thence flowing in full volume through the Gulf of Florida. I will here cite some notes of testimony given me by various persons specially acquainted with the matters in question; they were questioned more particularly with reference to facts and opinions touching a southwesterly current prevailing more or less between the easterly Gulf Stream and the Florida reef. Such a counter or eddy current is definitely indicated on Jeffrey's map of 1794 by a dotted line, above which is written : "North of this line is a current setting southwestward, unless when the wind is at north or east, which winds admit of no southwest," and "south of this line the current of the Florida Stream sets always northwardly."

Captain Geiger, who for over thirty years has been observing the waters of this vicinity, most of that time having acted as a pilot off Key West harbor, and who is perhaps better acquainted than any other person with the currents there prevailing, gives the following statement of facts: A strong north or northeast wind keeps the Gulf Stream back, and makes a westerly current near the shore. During June, July, and August, the westerly current prevails more than the easterly current, from five to fifteen miles from the reef. During December, 1857, the Gulf Stream ran very close in shore and across the reef. The direction of the current depends mostly on the wind. The westerly current prevails for from one-third to two-fifths the entire time, from year to year, for from two to fifteen miles outside the reef off Key West; he has known it twenty-five to thirty miles off Sand key. When the Gulf Stream is strongest on the Cuba shore the westerly current is strongest on the north side, and when it is weakest along the Cuban shore the Gulf Stream sets close along the reef. He has found the westerly current as far up as Carysfort, but not frequently, and not broad or strong. This current broadens from Carysfort to the westward, and continues about constant along its course. The tides on the two sides of the reef are about six hours apart on an average, but set on the whole as much one way as the other over the reef. Sometimes there is a narrow easterly current for a mile from the reef, then a westerly current, and then the Gulf Stream. Both the United States steamers Susquehanna and Wabash were set westwardly by the current about eight or ten miles during the past season. A considerable number of the Gulf traders know of the westerly current, and make more or less use of it in navigating westwardly. When running with the wind the water is smooth, and rough when against it. After northers the westerly current is to be expected. Sometimes in crossing to Havana no Gulf Stream indications are found, and sometimes a westerly current is found along the north shore of Cuba. Notwithstanding Captain Geiger's long observation of these currents, he says that he is quite unable to reduce them to rule, or in any way to know beforehand how the current will be found to set. He asserts that the Gulf Stream sets from the vicinity of Cape St. Antonio, northeasterly, through the Florida channel, and that the main stream does not make the circuit of the Gulf of Mexico, as generally supposed.

Captain Richardson, pilot of the Coast Survey steamer Corwin, says in substance as follows: The westerly current appears irregularly, chiefly in the winter, but sometimes during the prevalence of the regular trades. It extends from ten to fifteen miles off from Sand key, sometimes running as much as two miles per hour. It never prevails over the reef proper. It sets for two months or so some winters. It spreads further from the reef as it goes west; has known it as far north as Carysfort, just outside the reef, and at Cape Florida, even where the reef is narrow and deep, this current sometimes sets across it some two miles from the shore, but is not very frequently found there. As it runs west it seems to increase in breadth. Off Indian key he has known it extend seven miles from the edge of the reef, and at Bahia Honda it is sometimes ten miles, and at Sand key, from ten to fifteen miles. In the winter of 1856–'57 there was very little of this current. In crossing from Key West to Havana, the Gulf Stream runs much stronger on the Cuban side. To some extent navigators know this westerly current and use it with great advantage when bound west. In one case, in 1852, he knew of two vessels bound east pass Tortugas, which separated about a hundred miles in twenty-four hours by one captain's knowing this current and the channels, while the other kept in the westerly current. The tide between the Quicksands and Tortugas sets flood N.NE., and ebb S.SW., differing from the charts.

Captain Wilson, who has for several years been running on the vessel serving Fort Jefferson on Tortugas, as a mail boat, to and from Key West, says that for some three months prior to February 11, 1857, there was a strong and decided westerly current on the north margin of the Gulf along the reef between Key West and Tortugas. It had then for some two months been constantly to the west. Running out from Tortugas on an E.SE. or SE. course, and tacking to the N. or E. of N. when the point was reached, which in an ordinary Gulf Stream would bring him out somewhere from Sand Key light to six or seven miles west of it, which tack, if there were no currents, would bring him out abreast the Marquesas; he has six times in the last three months come out abreast the Quicksands, thus falling short of where he would have been had the water been still, by some eighteen to twenty miles, and some thirty miles west of Sand key, where he would have fetched during a full Gulf Stream current. It usually takes about twenty hours to run both branches of this tack. There is no appearance of any current on or within the reef either way, except the set of the tides. When the westerly current is running, he finds it better to beat up within the reef than to attempt to cross over into the Gulf Stream. Mr. Wilson thinks the current sometimes extends half way across to Cuba. He says this westerly current has prevailed more or less every minute for seven years that he has been running between Key West and Tortugas, but never so strong as this winter, nor for so long a time, probably not over a month in any previous case. He thinks the westerly current mainly disappears during the prevalence of the regular summer trades.

I was informed by General Totten that Commodore Bainbridge told him that in a voyage made by him some fifty years since, when he supposed himself in the Gulf Stream west of Cape Florida, he found by known land-marks that he had drifted a considerable distance to the westward instead of to the eastward.

I am indebted to Mr. Charles Tift, of Key West, for the three following notes:

"In December, 1856, (I think,) the barque Joseph Hale, from Philadelphia for New Orleans, got ashore ten miles southeast from Cape Florida light-house. She had passed round the 'Isaacs' and made the Orange keys. Steering for the Double Headed Shot Keys light, while looking out for the light, (the ship apparently going seven knots,) she struck, and proved to be in the position above stated.''

''The ship Rockland, from New Orleans to Boston, was off the Pan of Matanzas at 4 o'clock, (say March 25, 1858) wind E. SE., ship going, per compass, E.NE., intending to sight Double Headed Shot Key light. At 12 o'clock saw what was supposed to be the light on Double Headed Shot Key, and kept the ship off to pass it on the Gulf or western side. But the light proved to be the new one on Sombrero shoal, (just opposite,) of which the captain had no notice, and she struck a shoal inside the main reef. A glance at the chart will show how far these captains were mistaken in their estimate of both the force and direction of the currents.''

''Some years since a fishing smack left Key West to go to Cape Florida. The wind was eastwardly, and after she had beaten to windward for some forty-eight hours, she stood in to make the land. She fetched twenty miles to the westward of the starting point, showing in this instance a strong westerly current in the centre of the Gulf.''

Mr. Tift adds, that he ''knows that the 'Gulf current' sometimes, though rarely, runs strong to the eastward for a mile or more *inside* of the reef, (at Key West,) but that the general set is westward for a *short* distance from the main reef. The idea, however, of a 'strong westerly current' on this 'edge' must be taken with many grains of allowance. A ship-master leaving the strong Gulf current and approaching the margin finds the set so reduced in its rapidity as to conclude that he has found the stream actually going westward. As stated above, this is only true to a very limited extent; or, in other words, the belt of westwardly current is very narrow.''

I am indebted to Mr. Baldwin, collector at Key West, for a case in his own experience showing a westerly drift, and for some observations made specially valuable by his long and full acquaintance, not only with the matters in question, but with the navigators frequenting Key West.

In June, a few years since, Mr. Baldwin made a passage in a fast sailing brig from Mexico to Havana. After leaving Campeachy Bank they made Tortugas islands, and took a departure about sunset, steering about SE. by E. About midnight it fell calm, and for five days they experienced only calms and occasional light airs from the south. On the sixth day there was a light wind from the east. The master, an experienced navigator and well acquainted with those waters, steered south, supposing he had drifted through the Gulf. On the morning of the seventh day he made land, which he supposed was somewhere near Matanzas, but which turned out to be near the Colorados, a reef off the west end of Cuba.

Again, in a voyage from St. Mark's to Key West, Mr. Baldwin says, that being set by strong southwest currents in the bay of Mexico, they fell to leeward and made the Tortugas islands. Having an experienced pilot they ran through into the Gulf between the Tortugas and the Quicksands. After beating to windward for three days, they stood in and found themselves six miles to leeward of where they entered the Gulf. Satisfied that they had to contend with a strong westerly current, the master consented to beat up inside the reef, and they reached Key West in thirty-six hours.

Mr. Baldwin says he has conversed with many intelligent ship-masters, with the Key West pilots, and with the masters of fishing smacks, who are constantly crossing and recrossing the Gulf to and from Cuba, and says that they assure him that no dependence can be put on the Gulf Stream. Sometimes it runs very much stronger than at other times in a northeast direction; that it very frequently runs in a southwest direction; and that at other times there is no current at all. Very frequently they experience an easterly current on the Cuba coast, and the reverse on the Florida coast; at other times a strong current in the centre. The current cannot be mistaken, as the change is perceptible to the eye.

Mr. Baldwin adds: "A great deal depends on the force of the wind. My own observation has satisfied me that the wind influences the set of the Gulf Stream; for instance, after a heavy northeast wind the stream sets to the northeast at a very rapid rate, and *vice versa.* Since my residence at Key West I have known several vessels to be brought in from the northwest, having got into the bay of Mexico when supposing themselves east of Cape Florida." He was assured by the master of a vessel from Honduras, and another from Central America, both stranded, that they had come round Cape Antonio, and, after beating as they supposed in the Gulf, aided by the Gulf Stream, for a number of days, discovered land, and judging it to be the Bahamas, shaped their course through the Gulf, and were stranded near the Cedar Keys.

These scraps of testimony might be much extended if necessary, but I suppose they fully suffice to show that we are still very far from possessing the knowledge the case demands. They clearly prove that there is enough westerly current in the Gulf of Florida to be of vast importance to navigation if its movements can be defined, and to constitute a great danger if it is not known. Its variations are also well established, and should be known to navigators. I am also quite well persuaded, not only from actual testimony but from the fact that a coral bank extends above Cape Catoche, that at least a large part of the Gulf Stream turns to the northeast around the west end of Cuba, instead of making the circuit of the Gulf of Mexico. The effect of the earth's rotation and of its own inertia on the current coming north from the Caribbean sea, would be to give it an eastward bend. It is also quite incompatible with the widening of the westerly current towards Tortugas to suppose that the main Gulf Stream comes sweeping in from the mouth of the Mississippi at this point.

Before attempting to theorize on the cause of this westerly current it is certainly very desirable that it should be more accurately defined. The effect of dragging by the Gulf Stream along its sides may perhaps be to produce a deficiency of water behind, to be replaced by a return current of this degree of force, but it would certainly not call for such a vast body of westerly current as is vouched for in some cases. Some of the wrecks which have lately occurred seem due to a strong current setting through the Santarem channel, and we may see in this a suggestion of a cause for the westward currents when these exceed the magnitude of a proper eddy. A Santarem current projected across the Gulf may be thrown down the reef; though I should not much expect such a result.

It will be well here to call attention to the refutation of the theory that the Gulf Stream owes its progress to a declivity resulting from heaping up waters in the Gulf of Mexico which this parallel counter-current affords. There is no evidence of any such elevation of the Gulf of Mexico as this theory calls for. On the contrary, there is no such southeast current across from the bay of Mexico, Barnes' Sound, &c., as such an elevation would inevitably create. The whole notion of a descending river in the sea, with its source in the Gulf of Mexico, seems to me quite untenable, and conflicting with facts.

The natural conclusion from what has preceded is, that there is abundant need of further exploration into the movements of this whole system of currents. Their incalculable commercial importance makes such an inquiry anything but speculative, and should stimulate active and well-conditioned observations. We well know how imperfect the observations by the drift of ships must be; they are rather indications than measurements. In view of the present state of the case, I would ask attention to the promise of results offered by undertaking an extensive series of current bottle observations on the line from Cape St. Antonio to Cape Catoche. By systematic proceedings several points might be well illustrated. Suppose a vessel to cross on this line, say twice monthly for a year, throwing over one or two hundred bottles each time containing slips duly numbered so as to indicate each starting point accurately; these points being regularly distributed on the line run, and checked by the verification of the route sailed. As these bottles proceed on their course they will become faithful witnesses of the currents, and by their spreading they will show conclusively what the real course of the Gulf Stream is, and whether it is forked—one branch sweeping around the Gulf coast, and the other pushing on northeasterly. With a view to their being readily picked up at sea, I would propose that flasks of white glass blown with broad bases should be used. These could be seen at a distance; and in a region so crowded with sails as the Gulf of Florida very many would be picked up while still afloat, thus giving a true measure of mean velocity. A small sailing vessel, such as one of the Key West pilot-boats, or the revenue cutter at that station, might, by having a good observer put on board, make such a course of observations with slight expense in proportion to the results. It is hardly needful that I should here further state the bearings of such a plan, but I think all will concede to it the promise of elucidating some important questions of the Gulf currents. It would surely be much better could deep-sea observations also be made, and to some extent probably they might be connected with a current-bottle campaign. The superficial study ought certainly not to be long deferred; after this we can take a next step more wisely.

APPENDIX No. 33.

Extracts from the report of Assistant A. M. Harrison, relative to the topographical features of the shores of Ossabaw sound, Georgia.

UNITED STATES SCHOONER "PEIRCE,"
Vernon River, Ga., March 15, 1858.

SIR: * * * * * * * *

Ossabaw island.—The northern extremity of this island was surveyed, extending from the ocean to the "inland passage" and from Ossabaw sound, southward two miles, embracing an area of $10\frac{1}{2}$ square miles. The ocean shore is sandy, composed of a range of small hillocks, backed by an oak and pine forest. Westward of this Bradley's river extends in from the sound in a southerly direction, winding irregularly, and with its branches draining a large area of marsh, dotted here and there with little lagoons and ponds. This marsh is bounded on the west by the fast land, which extends as far as Crab creek, and the intervening space to the "inland passage" is occupied by creeks and sloughs and many hammocks, rising from islands in the marsh. Much of the fast land is under cultivation, cotton being the principal growth.

* * * * * * * *

Raccoon key, a marsh island, is situated in the western centre of Ossabaw sound, and its eastern side is exposed to the effect of easterly winds, being directly opposite the entrance of the sound. A considerable creek, with its branches, waters and drains the marsh with the flow and ebb of the tide. There are several hammocks of pines and other trees on the key.

An extensive shoal puts off from the eastern side, and upon its outer edge an old wreck is stranded, which last year was located outside, to the southeast of Great Wassaw island, having drifted since that time $3\frac{1}{2}$ miles in a westerly direction.

Little Wassaw island, situated between Ossabaw sound on the south and east, Odingsell's creek on the north, and Adam's creek ("inland passage") on the west, is divided nearly in half by Curtis creek, which runs in from the northern side of the island, is very crooked and has numerous branches in all directions, separating the hammocks on the west from Pine island and other hammocks on the east. The eastern shore is sandy, and also a portion of the southern. The hammocks are principally of pine, with some water oaks and palmettos. There is a small negro settlement on the island, but little or no cultivation.

Great Wassaw island.—The southern end of this island, included in the survey and the outer shore, consists mainly of sand, the extreme point being occupied by irregular knolls and a range of hills bordering the ocean, extending up the coast. Back of these is a forest of pines and other trees, reaching westward to Wassaw creek, which separates the woods from the marsh opposite. There are a few scattered hammock islands on this marsh. * * *

Burnside's island, located between the river of that name and Back river, is in a measure cultivated. The same growth characterizes it as most of the hammocks. Sugar cane was raised here last year. Like most of the plantations in this region, it has once been under a better state of cultivation than at present, and there are the remains of ditches and other evidences of a system of drainage.

Green island, on the north bank of Vernon river, opposite the mouth of the Little Ogeechee, presents the same features. It is separated from Skiddaway island by marsh and creeks.

Skiddaway island.—The southern end of this island, which is included in the survey, is for the most part under cultivation, and is bordered by pines, palmettos, and other trees. It is a large island, extending as far as Wilmington river, and has many plantations upon it and large tracts of timbered land. It forms the western boundary of the Romerly Marshes. There is an inland passage connecting, by way of Skiddaway Narrows, Vernon and Wilmington rivers, on the west side of this island, available only, however, at high tides. * * * *

Changes in the configuration of the shore-line are constantly occurring on this coast. The outer shore of Ossabaw island has been washed away to the extent of twenty-five feet within a period of twenty years. Large trees have been undermined and swept away as the sea encroached upon the shore, and upon Ossabaw beach live oaks may now be seen lying prostrate with their branches in the sea.

A station of the triangulation party, "North Ossabaw 1," (old,) erected and determined last year, is now gone, and the position where it stood, at the northern extremity of Ossabaw beach, is thirty-five metres from the present high-water mark. Southeasterly winds are those which tend most to this wearing away. The eastern shore of Raccoon key bears evidences of having been encroached upon by the sea. A palmetto is growing below the high-water mark, and stumps of decayed trees are seen still further seaward. The same is the case on the eastern shores of Great and Little Wassaw islands, and Egg island has lost considerably.

On the northern shore of Ossabaw island, opposite the plantation, some years ago there was a sand beach, now a narrow strip of marsh, varying from twenty to eighty metres, extends outside of it, separating it from the water. This is made land.

The rivers also change somewhat, particularly where there are sandy bluffs exposed to the current. Vernon river has widened considerably opposite Beaulieu, which is located upon a bluff.

The changes in depth at Ossabaw sound have not been very great. There is a difference of only two feet on the bar between that given by the English survey in 1786 and that of Captain Mackay in 1846, having gained that much in depth. * * * *

Respectfully submitted by your obedient servant,

A. M. HARRISON, *Assistant.*

Professor A. D. BACHE,

Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 34.

Extracts from the report of Sub-Assistant John Mechan, relative to the character of the eastern coast of the Florida peninsula below St. John's river.

WASHINGTON, D. C., *June* 1, 1858.

SIR: * * * The old military road from Mayport Mills to St. Augustine runs through the tract surveyed this season. Its general trend is nearly parallel to the coast, and its state of repair tolerably well suited to the light traffic of the locality.

Pablo creek rises in the interior of the peninsula, and after an extremely tortuous course of forty or fifty miles through a low, piney, uninhabited country, and finally (for thirteen miles) an open, marshy district, debouches into the St. John's river about three miles above its entrance. The creek is navigable for pilot boats twelve miles above its mouth, and affords transit for the pine lumber of the adjacent country by rafting to Mayport saw mills. * * * The ocean shore line is slightly curved towards the interior, and has a smooth, sandy foreshore of about eighty metres at extremely low water. It is skirted by a range of sand hills fifteen or sixteen feet high, having a width of from forty to a hundred metres. These are overgrown with scrub oak, stunted palmetto, and strong, wiry grass, which gives them a high degree of compactness and permanence, and, unlike the beach sand hills of the Carolinas, they are not very liable to be pierced by the ocean in heavy storms.

This portion of Florida is of diluvial formation, and generally a dead level, except where the hummock lands form slight undulations.

Shell deposits occasionally occur, but I have observed no indications of mineral.

About three-fourths of the land between the St. John's river and Diego plains is sandy pine barren, of small value for farming purposes, but the hummock lands having for ages been densely wooded with pine, live oak, and palmetto, have acquired a considerable vegetable deposit, and their soil, composed of clay mixed with sand, makes good arable land when properly cleared and cultivated. The mild humidity of the atmosphere, owing to the almost insular position of the district, causes the valuable sea island cotton to grow luxuriantly.

Five or six miles south of the St. John's river, and as far inland as the St. Augustine road, the country ceases to be thickly wooded, and assumes the appearance of prairie, covered by diminutive scrub oak, and dotted with clumps of pine, palmetto, live oak, and patches of marsh, swamps, and ponds. * * * * * * * *

Respectfully, your obedient servant,

JOHN MECHAN.

Professor A. D. BACHE,

Superintendent United States Coast Survey.

APPENDIX No. 35.

Report to the Commissioner of the General Land Office, showing the progress made during the surveying year in the survey and marking in quarter sections of the Florida keys.

COAST SURVEY OFFICE, *September* 28, 1858.

SIR: I have the honor to report that the survey of the Florida keys has been continued by two topographical parties working during the season between Key Largo and Vacas keys.

Five plane-table sheets, containing the last results, are now on file in this office.

The keys embraced in the operations of the present surveying year are generally small, and several of them were found too unstable to admit of the insertion of posts to mark the subdivisions into quarter sections.

With this report I transmit certified sheets showing the topographical features of a part of Long island, Plantation key, Upper and Lower Matecumbe, and Shell keys, the Bowlegs, Long key, the Conch keys, Duck key, the Channel keys, Crawl keys, Grassy key, and a part of Fat Deer key. The sheets are in triplicate, and notes are appended to each in conformity with the regulations of the General Land Office.

The annexed extracts from the reports of Sub-Assistant C. T. Iardella and Mr. F. W. Dorr, by whom the work was executed, show the sizes and general character of the keys, and contain, also, statements of the number of posts employed in the subdivisions.

During the season a triangulation party, working under the direction of Lieut. A. H. Seward, U. S. A., Assistant in the Coast Survey, completed a connection of the reef triangulation with the Cape Sable base, by a series of triangles extending northward and eastward from Lignum Vitæ key.

The topographical work on the keys is now well advanced towards completion.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. THOMAS A. HENDRICKS,
Commissioner of the General Land Office, Washington, D. C.

Extracts from the report of Sub-Assistant C. T. Iardella, on the survey of keys south of Key Largo.

WASHINGTON, D. C., *April* 28, 1858.

SIR: In conformity with your instructions, I proceeded to Florida and joined my party in the schooner Agassiz, in the latter part of November, for topographical work on the keys and patches lying between Key Largo north and Vacas keys.

Having found on examination at the office that only the outer shores of Upper and Lower Matecumbe had been traced by the party assigned in a previous season, and that some small intervening keys had been omitted, I started with the plane-table in that quarter of the reef, and have completed the work along the main line of keys from Windly's island, inclusive, (known also as Plantation key,) and extending southward and westward to embrace the greater part of Long key. The intervening patches designated as Vermont key, Shell key, another in that vicinity without name, Upper and Lower Matecumbe, and three small keys called Bowlegs, together with those first named, are shown on two sheets. One of these joins with Mr. Dorr's work of the season at Key Largo, and the other with his second sheet at Long key.

The characteristics of the keys in this locality are well marked by beaches of white sand on the outside, backed by unbroken mud flats, which constitute the middle and inner side of each. The surface is of no value whatever considered as land.

I append general descriptions of the size and character of the principal keys surveyed by my party during the present year.

Windly's key is a mile and a quarter in length by a quarter of a mile in breadth, and is entirely covered with water at ordinary high tides.

Upper Matecumbe is a long narrow key, thickly wooded with black and red mangrove. Its shore on the seaward side is sandy and bordered with trees. The opposite side is hidden by mangrove bushes, which grow far into the water. This key is four miles long by a quarter of a mile in breadth. The surface was not marked by posts, the mud on the northern shore being so deep and in most places so soft that stakes pushed to the depth of ten feet would not find hard bottom. The mud resembles white marl.

Lower Matecumbe is also about four miles long, and quite narrow like the key last described. In every other respect it resembles Upper Matecumbe, except that the surface is somewhat more stable. This key was marked in quarter sections by eleven wooden posts, their sides bearing the letters M, MP, and P, corresponding with the direction of meridians and parallels.

Long key is of peculiar shape, and has a lagoon running its whole length. The outer shore is sandy, but the inner side is an extensive mud flat. Its length is three miles and breadth a mile and a quarter. The land sections on Long key were marked by nine posts, designated like those on Lower Matecumbe.

Several keys lying northward and westward from the line of keys just surveyed yet remain to be represented on the two sheets.

My work in this vicinity was closed on the 1st of February, the party being then transferred to Section VII. * * * * * * * * * *

Very respectfully, yours, &c.,

C. T. IARDELLA,
Sub-Assistant Coast Survey.

A. D. BACHE, LL.D.,
Supt. U. S. Coast Survey, Washington, D. C.

Extracts from the report of Mr. F. W. Dorr, on the survey of keys between Key Largo and Key Vacas.

BOSTON, *April* 23, 1858.

SIR: In accordance with your instructions, dated September 30, 1857, immediately after the close of operations in Section II, I proceeded to Key West, where I took charge of the schooner Dana on the 22d November. Active operations were commenced a few days later among the Vacas keys, joining my work of last season in this section.

The first sheet executed takes in the lower part of Fat Deer key, which is two and a quarter miles in length. This key is divided lengthwise by a lagoon some three-quarters of a mile wide. Its southern half is a low, narrow strip of land, mostly wooded. Between this and Grassy key, the next of any importance, are some half a dozen small islands, generally known as the Crawl keys. They are mostly covered with mangrove, and are low and muddy, with beaches of sand on the sides that look towards the reef. Grassy key is two and three-quarter miles long, and from one-quarter to three-quarters of a mile in breadth. The land is, in many places, high, and supports a growth of button-wood and palmetto, with less than the usual proportion of mangrove. Parts of it are cut up by lagoons, but there are also tracts of prairie, on which the land is much better than is ordinarily found in this section. In this immediate vicinity lie the Tom's Harbor keys, two in number. The largest is but half a mile in length and very narrow.

The plane-table sheet of this quarter is marked by fifty-two iron and wooden section-posts, labelled U. S. C. S. on one side, and M, P, or MP, respectively, on the other.

To the northeast of the keys last mentioned, and forming the western limit of a second sheet, are Duck key and Channel key, both of them small and wooded with little else than mangrove. Duck key, the largest, has a small prairie on the southwestern extremity, on which yet remain the ruins of an old habitation. Looking from this in the direction of Long key, an interval of more than four miles will be seen, interrupted only by the three Conch keys, which lie about one and a half mile northeast of Duck key. They are quite small, the largest being less than one-quarter of a mile in length.

Between these and Long key a channel leads across the reef into the bay. It can be used by vessels drawing not more than seven feet. The second sheet also embraces the western half of Long key, where I joined with the work of Sub-Assistant Iardella. Its northern shore is irregular and composed of jagged coral rock; the southern or outside shore is a continuous sand beach. This key is wooded throughout, chiefly buttonwood, with a few palmettos, and but a small amount of mangrove.

The surface of keys represented on this sheet is marked with twenty section-stakes, labelled as before mentioned.

A third sheet, separated from the others by work of Sub-Assistant C. T. Iardella, commences at the southwestern extremity of Long island, some eight or nine miles to the eastward of Indian key. The outside shore-line had been run during the previous season by Sub-Assistant Wainwright. As no triangulation had been done on the inside, two points on the sheet of Sub-Assistant Iardella were chosen, and from these as a base I extended a plane-table triangulation along shore, and among the keys to the northward. In this way the inside shore of Long island was traced as far as Tavernier creek, which separates it from Key Largo. Also the shores of several small keys, and outlines of shoals to the north and northwest. Here the shoals form a bulkhead, beyond which it is impossible to carry more than three and a half feet of water, and that only through a very narrow, crooked channel, and at high tide.

*   *   *   *   *   *   *   *   *

Yours, very respectfully,

F. W. DORR.

Prof. A. D. BACHE,

Supt. U. S. Coast Survey, Washington, D. C.

APPENDIX No. 36.

Extracts from the report of Sub-Assistant F. W. Dorr, descriptive of Caloosahatchee river, Pine and Sanibel islands, and San Carlos bay, on the southwestern coast of the Florida peninsula.

BOSTON, *April* 23, 1858.

SIR: *   *   *   * The Caloosahatchee river preserves an average width of above a mile for some twenty or twenty-five miles back from its mouth, where it suddenly narrows to a width of only fifty yards. It is quite shallow and the mouth is filled with oyster reefs, so that it can never be of much importance for purposes of navigation.

The southern part of Pine island is much cut up by lagoons for some distance back from the shore, but in the interior there is a large prairie, and north of it an extensive pine barren. The pines are mostly large, averaging from sixty to eighty feet in height. The shore is fringed with mangrove. This belt, however, rarely attains a breadth of more than two hundred metres.

In the bay included between the mouth of the Caloosahatchee river and Pine island there are some half a dozen keys, small, wooded with mangrove, and of but little importance. This space is also full of small oyster beds, most of which are dry at low water. Many of them are entirely covered only at spring tides. One of the keys, within about two-thirds of a mile of Punta Rasa, has been used for several seasons by a party of fishermen, and operations are carried on during the winter on quite an extensive scale.

The southeast half of Sanibel island was included in my topographical survey. Its outside shore is a sand beach, and that character of surface extends also to the inside as far as Middle Point, a distance of about three miles and a half. Beyond that a number of lagoons run back some distance into the interior of the island, the mangroves as usual growing to the edge of the water and forming the shore-line. The middle of the island is not wooded. The land lies six or eight feet above the level of the sea, in ridges which run lengthwise of the island, and is entirely open, with the exception of scattered clumps of palmettos. The surface is composed of a mass of small shells. I found no traces of the coral rock, although we frequently dug deep enough for water. It was in all cases too brackish to be agreeable to the taste.

There are two or three peculiar creeks or ditches on the prairie. The longest measures upwards of three miles. These have no outlet, and are not more than from forty to sixty feet in width. The water in them is but two or three feet in depth, and neither ebbs nor flows. It is brackish.

San Carlos bay forms an excellent harbor for vessels drawing no more than nine feet of water. This draught can be carried as far up as Punta Rasa.

Yours, very respectfully,

F. W. DORR.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 37.

Investigation of the laws of motion governing the descent of the weight and line in deep-sea soundings; by Prof. W. P. Trowbridge, Assistant in the Coast Survey.

COAST SURVEY OFFICE,
Washington, D. C., May 31, 1858.

DEAR SIR: On receiving directions from you to examine the deep-sea soundings of Lieut. Comg. Joseph Dayman, R. N., along the line previously explored by Lieut. Comg. Berryman, I took advantage of your suggestions and made an investigation of the laws of motion of the sounding weight and line used in deep-sea soundings. This seemed to offer the best mode of arriving at correct conclusions with regard to the probable errors of the results generally obtained by the methods employed, by which means only the values of the results can be determined and comparisons of different results made.

Having had opportunities of consulting with you from time to time, I have been enabled to follow out your suggestions more satisfactorily than I could otherwise have done.

The substance of the report which I have the honor to submit herewith was given by your kind permission at the late meeting of the American Association, and I have prepared it in a form to be printed with the proceedings of the Association, if you should think it advisable.

The conclusions to which the investigations lead seem to be briefly as follows:

1. The sounding weight reaches its maximum velocity within the first three seconds of time after the weight has reached the surface; this maximum varies with the form and specific gravity of the weight, being 16 feet per second for a 32-pound shot and 27 feet for a 96-pound weight, such as was used by Lieut. Comg. Dayman.

2. When the line begins to offer resistance to the motion the velocity is rapidly diminished, becoming at the depth of 2,000 fathoms only two or three feet per second, and at 3,000 fathoms still less.

3. This diminution of velocity is due entirely to the resistance offered by the line, the resistance offered by the sinker being at the depth of 2,000 fathoms only a fraction of a pound, while that of the line amounts to nearly the whole weight of the sinker, the excess of the weight of the sinker being sufficient to impart a very small velocity to the line.

4. The resistance upon the line varies, first, as the square of the velocity; second, as the diameter of the line; third, as the length of line immersed.

5. The variations of gravity do not sensibly affect the rate of sinking.

6. The variations of density do not increase the resistance at great depths, but it appears that bodies which are compressible will fall more rapidly at great depths than near the surface.

7. The smallest line that can be used with safety will give rise to sufficient resistance to support nearly the whole weight of the heaviest sinker at considerable depths.

8. The probable error of results when the length of line paid out is taken as the depth are so great that this method is the most unreliable for determining the depth.

9. The method of ascertaining the depth by "Massey's Indicator" is the best that has been devised, provided the indicator be always used with the same line and weight. This method, however, has been also very unsatisfactory, giving large errors on account of the faulty construction of the machines used.

10. The results of Lieut. Comg. Dayman were obtained from the former method, those of Lieut. Comg. Berryman by the indicator; and, therefore, Berryman's results are undoubtedly nearer the truth than Dayman's, but from neither can the existence of a "plateau" between New Foundland and Ireland be made out.

There is yet, it seems to me, nothing to show that the bottom of the sea presents features any different from the face of the country across any portion of our territory, except, perhaps, the highest mountain ranges. The highlands of the Hudson, for instance, would be unnoticed on this "plateau."

11. To obtain correct results, some improved method of registering the depth seems to be necessary, and I would respectfully suggest a modification of Mr. Saxton's Current Indicator to suit the circumstances of the case.

I would also beg leave to suggest the coiling of the line within a cylinder which is to be attached to the weight, so that the line will uncoil from the moving body. By this means the resistance due to the motion of the line in the water will be avoided. If this be practicable much greater depths may be reached, and the weight will descend through all depths with a rapid and uniform velocity.

The mode of registering the depth may be the same as heretofore used, with less liability to error, on account of the short time required for the apparatus to sink to the bottom.

When the time required for the weight and line to sink to the depth of 3,000 fathoms is now one hour and a half, by the method proposed, the apparatus might be made to sink to the same depth in fifteen or twenty minutes, and to smaller depths in proportionally less time.

Yours, very respectfully,

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DEEP-SEA SOUNDINGS.

The explorations of the Gulf Stream by officers of our navy, in connection with the survey of the coast, first gave rise to systematic efforts to determine sections of the bottom of the sea along continuous lines of great depth; afterwards the extensive system of deep-sea soundings executed under the direction of the Navy Department, through the exertions of Lieut. Maury, furnished most useful experience and results, and more recently the soundings along the line of the proposed Atlantic telegraph, first by Lieut. Comg. Berryman, United States navy, and again by Lieut. Comg. Joseph Dayman, R. N., have shown that to reach the bottom of the sea is not beyond the power of human effort.

Notwithstanding so much has been done to overcome the practical difficulties which formerly embarrassed and discouraged any attempts to sound at great depths, it is undeniable that much uncertainty exists in the determinations that have been made even when the depth is not greater than 2,000 fathoms; while below 2,000 or 2,500 fathoms, the errors and uncertainties amount to failures; and a limit has been reached beyond which it seems difficult to pass.

When the subject is viewed as a mechanical problem it seems hardly possible, however, that insurmountable obstacles can exist to its practical solution. The facility with which an observer can place himself over any point, the distance of which below the plane on which he rests it is his object to determine, and from which he is separated by a medium freely and almost equally penetrable at all depths, the laws of which are well known, would seem to offer greater hopes of our being able ultimately, to determine the depressions of the bottom of the ocean by a greater number of observations, and with greater accuracy, than the elevations of continents.

The solution of the question requires that the difficulties which have been found to exist in the present methods of sounding, should be clearly determined and overcome, and when these methods fail, that they should be improved, if possible, or new ones substituted.

It will be seen, on the least reflection, that the difficulties are of a mechanical nature; not simply practical, for all that skill and experience can accomplish has been effected in overcoming the practical difficulties which have been met in applying the ordinary methods; but the methods which are most naturally adopted for small depths fail, when the depth is very great, on account of their inapplicability in the latter case.

It is important to separate those difficulties which may be overcome by skill and experience from those which, under the most favorable circumstances and conditions, are still as great as ever, and depend only upon the mechanical forces developed; and, of course, some proof will be required to show that the obstacles presented by the latter causes are in the present mode of sounding, almost, if not quite, insurmountable.

If we suppose the water of the ocean to be in a state of rest, a sounding weight and line will descend according to the laws which govern the falling of heavy bodies in a resisting medium; the combined weight of the sinker and line in the water being the accelerating force, and the resistance offered by the water to the motion of the weight and line the retarding force; and upon the relative magnitudes of these forces, the circumstances of descent will depend.

The weight of the sinker and line in the water may be easily determined from their specific gravities; and for the purpose of determining the nature of the resistance upon these bodies, moving in the water, we have numerous experiments.

The experiments of Dubuat, given in the "Principes d'Hydraulique," furnish data for determining the resistances to the motion of bodies whose forms and dimensions correspond to the sinkers generally used in sounding; and the numerous experiments in deep sea-sounding, to which reference has been made, especially those of Lieuts. Lee and Berryman, U. S. N., afford the means of determining the resistance of the water upon the line.

In these latter experiments the rate of descent was accurately observed, and the results of numerous trials, with different weights attached to the same line, and with different lines, furnish the means of ascertaining the velocity of descent in each case at every point of the path described by the falling body, with sufficient accuracy to determine all the circumstances of motion.

The problem then becomes one of the most simple in mechanics, viz: having given the space, time, and velocity corresponding to the fall of a given weight in water, to find the law of resistance to the motion.

In some respects the problem is a new one. Although the resistances to the motion of any body in water, under ordinary circumstances, are known to be proportional to the squares of the velocities, yet the experiments from which this rule was deduced were made upon bodies of certain regular forms, the lengths of which, compared with the diameter of their cross section, was not very great; and it will be at least interesting to know whether this law is true with reference to a line of great length and small diameter, and especially when this line is subjected to the great pressure which is exerted upon it in the great depths of the ocean. The resistance in this case is entirely due to the velocity which is imparted to a certain quantity of water along the line by its motion, and not to friction in the ordinary sense of the term. If the resistance from friction be at all considered, it must increase greatly with the depth, since the pressure is increased by fifteen pounds on every square inch for every thirty-four feet in depth. It will be seen by the subsequent discussion that the pressure has no influence in increasing the resistance.

Again, the density of the water at great depths, as affected by the compressibility of that fluid, must be considered, and also the variations of the force of gravity, which will, of course, depend upon the depth. These circumstances make the solution of the problem of interest when considered in relation to the experiments which have been made upon the motion of bodies in water, under ordinary circumstances, at the surface of the earth; and the discussion of the subject should enable us to determine the best means of overcoming the difficulties which now exisit in sounding to great depths.

The experiments of Lieuts. Lee and Berryman were made with one and two 32-pound shot, (iron,) the line used being about seven-hundredths of an inch in diameter, and capable of bearing a strain of sixty pounds, the weight of one hundred fathoms in air being about one pound.

The mode of observing was as follows: Several thousand fathoms of the line were coiled upon a reel of light construction, marks being first placed along the line at intervals of one hundred fathoms; the end of the line was then attached to the weight, one or two 32-pound shot, as the case might be, and the shot dropped into the sea. The rate of descent was observed by noting the time of running out of each one hundred fathoms by a chronometer. The experiments were made from a boat which was kept accurately over the descending line by the oars. In this manner the effects of the drifting of the boat in giving apparently a more rapid descent and a greater depth, was avoided; and although it is probable that in many instances the drift of the boat was considerable, yet the mean results of the experiments of Lieuts. Lee and Berryman, from observations extending through several years, differ only by a small constant quantity, which is inappreciable in the determination of velocities to the depth of one thousand fathoms, and below this the difference is still slight. I have therefore made use of the experiments of Lieut. Lee, which, in some respects, are preferable (and which are sufficiently numerous to give good results) rather than a mean of the results of Lee and Berryman.

The intervals of descent for one and two 32-pound shot are given in the table (I); the first column shows the depth in fathoms, the second the intervals of descent in time for each successive one hundred fathoms.

The velocities are determined from these intervals by supposing the motion uniform during the running out of each one hundred fathoms, and dividing the space in feet by the time in seconds, which will give very nearly the velocity in feet at 50, 150, 250, &c., fathoms. The velocities at these points are given in the third columns under their respective heads.

It will be observed that the velocities of descent diminish in the case of one 32-pound shot, from 8.83 feet per second at fifty fathoms to 2.84 feet at one thousand, and 2.09 feet at two thousand fathoms, and so on. And in the case of two 32-pound shot, from 12.50 feet per second at fifty fathoms to 3.48 feet at one thousand, and 2.99 feet at two thousand.

The curves representing these circumstances of motion are given in diagrams marked (A,) the vertical distances representing the spaces in fathoms, and the horizontal distances for curves (1) and (2,) representing intervals of time, and for curves (3) and (4) velocities in feet. Curves (1) and (2,) therefore, show the relation of the spaces and times, and curves (3) and (4,) the relation of spaces and velocities. The curves in full lines are for one 32-pound shot, and those in broken lines for two 32-pound shot, the sounding line being the same in both cases. As these bodies have no initial velocity, but start from rest at the surface, it is evident that the curves of velocity must pass through the origin, (0,) and as their velocities are already diminishing rapidly at fifty fathoms, it is interesting to determine the point of maximum velocity. For this purpose we must refer to the mathematical formulæ for the motion, which are well known. In case of a heavy body falling in water, the velocity expressed in terms of time, weight, density of medium, and form of body, is given by the following expression:

$$V = \sqrt{\frac{2\,g\,W}{S.\,D\,(m+q)}}\left(\frac{N-1}{N+1}\right)$$

In which (g) represents the force of gravity, (W,) the weight of the body in water, (S,) the area of the greatest cross section of the body, (D,) the density of the water, and $(m+q)$ a constant determined by experiment; and the Hyperbolic Log. of $N = \frac{t}{P}\sqrt{2\,g\,W.\,S.\,D.\,(m+q)}$. In this latter expression (P) represents the weight of the body in air, including also, the weight of the fluid drawn along by the body, and (t) the time in seconds.

The velocity will increase as (t) increases, and will become constant when the factor $\frac{N-1}{N+1}$ becomes unity, and it is evident that when (t) becomes so great that N may be taken for $N-1$ and $N+1$, without sensible error, the velocity will have become nearly constant and will be represented by $V = \sqrt{\frac{2\,g\,W}{S.\,D\,(m+q)}}$.

In the case under consideration $g = 32.189$ (feet), $W = 27.38$ (pounds), the weight of a 32-pound iron shot in sea water, $S = 0.21$ (square feet), D represents the weight of one cubic foot of sea water $= 64.177$ (pounds) and $(m+q)$ as determined by Dubuat in the experiments given in the "Principes d'Hydraulique" for a sphere moving in water $= 0.5$. These constants, substituted in the formula, give for one 32-pound shot falling freely in sea water:

$V = 16.21$ (feet per second) for the maximum velocity.

To find the space passed over before this velocity is reached, we have this expression:

$$Z = \frac{2\,P}{S.\,D\,(m+q)}\ \text{Log.}\ \frac{N+1}{2\sqrt{N}}$$

Or when $N+1$ may be taken for N, this expression may be placed under the form—

$$Z = \frac{2\,P}{S.\,D\,(m+q)}\left(\frac{1}{2}\,\frac{t}{P}\sqrt{2\,g\,W.\,S.\,D\,(m+q)} - L.\ 2\right)$$

The time which must elapse before N becomes so great that $N+1$ may be taken for it, may be determined from the expression:

$$L.\ N. = \frac{}{P}\sqrt{2\,g\,W.\,S.\,D\,(m+q)}$$

substituting in this expression the values of the known quantities for a thirty-two pound shot we have—

$$L.\ N. = t\ (3.13)$$

For 1^{sec} L. N. $= 3.13$ and $N > 10$

For 2^{sec} L. N. $= 6.26$ and $N = 1000$ nearly.

For 3^{sec} L. N. $= 9.39$ and $N = 10000$ nearly.

Thus at the end of the third second N becomes so great that $N+1$ may be taken for N without sensible error in determining the velocity and space, and the formula for the space gives—

For the first and second seconds—

1^{sec} $Z = 9.11$ feet.

2^{sec} $Z =$ 25 feet nearly, and 16.21 feet for each second afterwards.

The velocity of the shot reaches its maximum therefore before the resistance of the line has any great effect in retarding its motion; that is, during the first two or three seconds. Two

32-pound shot placed side by side will, of course, fall in the same time, and will attain the same maximum velocity, and the value 16.21 (feet) will be also the maximum for two 32-pound shot; when the resistance of the water upon the line is developed, however, the greater weight will have the greater power of overcoming this resistance, and its velocity will be retarded less than in the case of one 32-pound shot, and the curves representing the velocities will commence to diverge at the maximum point.

It will be seen from the curves that the velocities diminish very rapidly for the first three or four hundred fathoms, then more slowly, and in case the specific gravity of the line is nearly the same as that of water, the vertical OC. will become tangent to the curve of velocity at an infinite distance, and will become sensibly tangent at the depth of a few thousand fathoms, or, in other words, the velocity of the sounding weight will be almost entirely destroyed. If the line is much heavier than water and incompressible, as in the case of a wire, the velocity will reach a minimum at a certain depth, generally less than 2,000 fathoms, and will afterwards increase. Both of these cases have important bearings, as will be seen hereafter.

The velocities, as determined from experiment, show but little diminution below 2,000 fathoms; but the number of cases below that depth was much less than at smaller depths, and moreover the difficulty of determining the intervals correctly, below this depth, is very great; the action of currents on the line, the drift of the boat, &c., when three miles of line are out, would affect the determinations greatly, and it seems to be preferable to determine these lower velocities by induction; instead of finding a velocity of two feet at 3,000 fathoms, the actual velocity, as determined by the curve, will not be greater than one foot and a half.

The curves of velocities seem to approach nearer to the hyperbola than any other form.

The resistances which cause this diminution of velocity in the descent are due entirely to the constant increase in the length of line, since, as we have seen, the resistance which would be enp to the shot falling alone corresponds to a constant velocity of 16.41, (feet;) and as the velocity is diminished the resistance to the shot is diminished. To separate the resistance upon the line from that due to the shot, and to find the amount of these forces in pounds we have for the resistance upon the shot at any point,

$$R = S.\ D\ (m + q)\ h,$$

h being the height due to the velocity, and if at any point of the path described the motion be supposed uniform for one second, we shall have, calling (W) the weight of the shot, and line in water (R^1,) the resistance upon the line and (R) the resistance upon the shot or sinker,

$$W - (R + R^1) = O,$$

that is, the resistance is equal to the weight.

This is the simplest mode of considering the subject. If the inertia of the masses be taken into account, we must employ the expression—

$$\int_b^a W\,dz - \int_b^a R\,dz - \int_b^a R^1\,dz = \tfrac{1}{2} M\,(V^2 - V^2{}_1)$$

V and V^1 being the velocities at any two depths (a) and (b) and the first member representing the quantity of action of the accelerating and retarding forces.

The term $\frac{1}{2} M\,(V^2 - V^2{}_1)$ involves the resistance opposed by the inertia of the shot and line, while the velocity is diminished from V to V^1, and the resistance opposed by the inertia of a quantity of line equal to the distance (b—a) as it is drawn from the reel at rest, and a velocity

V^1 imparted to it. If the distance $(b—a)$ equal unity, or one foot, V and V^1 may be considered equal, and the latter expression reduces to the first equation, and by finding the relation between the quantities in the first equation at different points of the depth, the values of the forces of these points will become known, and their variation with the depth will be exhibited.

The expression $W - (R + R^1) = O$, or, $\left(W - (S.\ D\,(m+q)\,h - R^1\right) = O$, involves two variable quantities, $(g,)$ the force of gravity and (D) the density of the water.

The variations of gravity within the external surface of the earth, supposing the density of water to be the mean density of the earth, are proportional to the distance from the centre of the earth, and if (g) represent the force of gravity at the surface, (g^1) the same force at the depth z, and (r) the radius of the earth, we shall have—

$$g^1 = g\left(\frac{r - z}{r}\right) = g - g\,\frac{z}{r.}$$

The equatorial radius in fathoms is equal to 3,487,266, and at the equator, for a depth of 3,000 fathoms, we shall have $g^1 = g - g\,\frac{3000}{3487}\ \frac{3000}{3487266}$, the second term being only .0004 of the force of gravity; but the density of the water is less than the mean density of the earth, and the force of gravity will therefore not diminish with the depth, but in a less ratio; so that the amount of diminution at 3,000 fathoms will be less than .0004 of the force; we may therefore consider the force of gravity constant; and in reality its diminution due to depth will be less than its variation with the latitude on the surface.

The density of the water increases with the depth, according to the law of compressibility of water, and to find the variations of density with depth we must refer to the law of compressibility.

From a report of Mr. Schott, it appears that the shortening of a column of water from the pressure due to 600 fathoms is two fathoms; or the cubical diminution is about .0001 of volume for one atmosphere.

The density being inversely as the volumes, for a given weight, we shall have, supposing (D) to be the density at the surface, and (D^1) the density at the depth z—

$$D^1 = D \cdot \frac{1}{1 - .0001 \cdot \frac{z}{33.90}}$$

From this expression we find the density—

At the surface $= 1.029$
At 1,000 fathoms $= 1.048$
At 2,000 fathoms $= 1.066$
At 3,000 fathoms $= 1.084$.

This increase of density is too small to affect sensibly the buoyancy of the fluid, or the resistance to motion, when considered with reference to the quantities which we wish to determine.

The weight of a 32-pound shot, for instance, in water, at the surface will be $W = 32 - 32 \cdot \frac{1.029}{7.2}$, the numerator and denominator of the last term being the specific gravities, respectively, of water and cast-iron.

At 3,000 fathoms the weight of the shot would be $W = 32 - \frac{1.084}{7.2}$, and we see that the variations fall within the range of the specific gravities of the different varieties of cast-iron.

The variation, as affecting the resistance to motion, will be shown in the expression $R = S. D (m + q) h$, where it is impossible to determine $(m + q)$ or (h) within the range of variations of (D.) We may, therefore, regard all the quantities as constant and known in the expression $W - (S. D (m + q) h) - R^1 = o$, except $(R^1,)$ which represents the resistance upon the line, and may be determined from the equation.

If the specific gravity of the line be very different from that of water, we shall have $W = W \pm W^1 z$, in which $(W^1 z)$ is the weight of that part of the line immersed; the plus sign being used when the line is heavier than water, and the minus sign when it is lighter, and (W^1) being the weight in water of 1 foot of line.

In the experiments with one and two 32-pound shot, the specific gravity of the line is supposed to be the same as that of water, and it is only in case of a wire being used, or a hemp line of large diameter, that it is necessary to take the specific gravity into account. As we wish to determine the *laws* of the resistances and not their absolute quantities in pounds, except in general terms, these very small quantities may with propriety be neglected.

We may now find the values of R^1 at different depths in the cases under consideration, viz: the fall of one and two 32-pound shot attached to a small line.

For one 32-pound shot $W = 27.36$ pounds, and the values of $S. D (m + q) h$, for the different velocities in the third column of the table may be calculated. At the maximum velocity there is practically no line attached, as the action of a few feet may be neglected, and the whole resistance will be equal to 27.36 pounds, or equal to the weight of the shot in water, which is determined also from the expression $V = \sqrt{\frac{2 g W}{S. D (m + q)}}$, from which $R = S. D (m + q) \frac{V^2}{2 g} = W = 27.36$ pounds.

The resistances to the shot are given in the fifth column of the table, and the curve representing these resistances, in pounds, is given in diagrams marked (B,) curve No. 1. Sketch No. 38.

The values of $R^1 = W - S. D (m + q) h$, are given in the sixth column of table (I.)

It will be seen that the resistance to the shot diminishes very rapidly at first, and at the depth of 2,000 fathoms it becomes only 0.5 of a pound, while the resistance upon the line increases with the depth, becoming at 2,000 fathoms $27.36 - 0.5 = 26.8$ pounds.

For two 32-pound shot with the same line, the resistances at the maximum velocity will be 54.72 pounds, and at 2,000 fathoms 1.97 pound; the tension of the line in this case is, at 2,000 fathoms, nearly equal to its bearing weight, which was only sixty pounds. How much further would it have gone without breaking, and thus *indicating bottom?*

The diagrams marked (B) represent the laws of the resistances to the sinker or shot, and to the line, respectively. The curves in full lines relate to one 32-pound shot, and those in broken lines to two 32-pound shot. Curves (1) and (2) represent the resistance to the shot, in pounds, at depths of 50, 150, 250, &c., fathoms, the abscissae representing pounds. Curves (3) and (4) represent the resistance to the *line* at corresponding depths.

Diagrams, in every respect similar, have been made for the descent of sinkers of 126 and 96 pounds attached to the ordinary deep-sea line, which is about $\frac{4}{10}$th of an inch in diameter, and also for weights of 35 and 96 pounds attached to a silk line $\frac{1}{10}$th of an inch in diameter. These latter results were obtained from the observations of Lieut. Comg. Joseph Dayman, who sounded across the Atlantic along the line proposed for the ocean telegraph, in the summer of

1857. The deductions from Lieut. Dayman's experiments confirm those obtained from the observations of Lieuts. Lee and Berryman.

A glance at the tables or curves will show, 1st, that the velocity of a descending weight and line, even with the smallest line, diminishes very rapidly after it has attained its maximum, which always occurs very near the surface; 2d, that at the depth of about 2,000 fathoms the velocity is hardly two feet per second; 3d, that at this point nearly the whole resistance is due to the line, the resistance to the sinker being only a fraction of a pound; 4th, the resistance upon the line increases with the depth, becoming nearly equal to the weight at 2,000 fathoms; 5th, comparing the resistance upon the line when attached to one 32-pound shot and two 32-pound shot, respectively, these resistances for the same depth, or length of line, seem to be proportional to the squares of the velocities. To determine whether this law be true table (V) has been constructed, in which the ratios of the resistances in pounds at the same depths in the two cases are compared with the squares of the velocities. The ratios agree very nearly, the means differing by only a small fraction.

In table (IV) the same result is obtained with a larger line—the deep-sea line—the moving weights being 126 and 96 pounds.

We may therefore conclude that for the same length of line, moving with different velocities, the resistances are proportional to the squares of the velocities.

To ascertain the law of variation with the length, I have taken those points in the two cases at which the velocities are the same, corresponding, of course, to different depths or lengths. The results are given in table (III) where the ratios of the lengths are compared with the ratios of the resistances. From this table it appears that the resistances are directly proportional to the lengths; that is, if R represent the resistance upon a given length moving with a velocity V, the resistance upon double the length moving with the same velocity would be 2 R.

This does not appear to hold true for all depths; for if we take the differences between the lengths corresponding to the same velocity, for different velocities, or what is the same thing, different depths, and compare these differences of length with the differences of resistances, the resistances appear to diminish with the depth. This is particularly the case with the deep-sea line, where a given pressure of the water will have a greater effect in diminishing the diameter. It would seem to be a result which ought to have been expected, viz: that in case of compressible lines the pressure of the water, instead of increasing the resistance to motion, diminishes it, since the combined tension and pressure tend to diminish the diameter of the line; while, as we have seen, the change of density is so small that no sensible increase of resistance to motion among the particles is produced.

This fact I do not consider *conclusively* shown by the investigation; for although in the last two columns of tables VI and VIII the numbers expressing the ratios of resistances, when compared with the ratios of the lengths, appear to diminish with the depth, yet, from a want of knowledge of the diameter and specific gravity of the lines used, it is impossible to detect very slight variations in the resistances. The conclusion is a natural one, however, that the diameter of the line being diminished by the combined pressure and tension, the resistance will diminish with the depth.

The observations which I have discussed are not sufficiently numerous to determine with certainty the influence of increasing or diminishing the diameter of the line. Taking the deep-sea line and the small line, seven-hundredths of an inch in diameter, the resistances to the same length moving with the same velocity appear to be proportional to the diameter.—(Table VII.) The diameters were probably as 1 to 3 or 4; but the diameter of the deep-sea line was not exactly given.

The resistance of the water upon a sounding line may therefore be represented by the following expression:

$$R = (\text{constant}) \times \sqrt{S}.\ l.\ V^2, \text{ in which}$$

S represents the cross section of the line; l represents the length; V represents the velocity. The constant must be determined by experiment.

From these results we are justified in drawing the following conclusions:

1st. The resistance to the sinker, forming such a small part of the whole resistance at great depths, its form is not a matter of importance. 2d. With regard to its weight; the effect of a heavier sinker is to increase the velocity during the first part of the motion, which develops a greater amount of resistance upon the line, requiring, of course, a stronger line. With the line used in the experiments with two 32-pound shot the resistance became so great at the depth of 2,000 fathoms that a slight addition to the velocity by means of a greater weight would have broken the line; and this result generally attended all attempts to make very deep soundings with the line attached to three or four 32-pound shot. Thus increasing the weight requires a larger line and causes an increase of the resistance in the double ratio of the diameter of the line and the square of the increased velocity; the resulting velocity at great depths will therefore remain nearly the same, a result which is found in practice.

The experiments with one 32-pound shot attached to a small line, given above, probably involve the most favorable conditions as far as regards the weight, form of weight, and diameter of the line.

3d. The uncertainty of knowing the exact instant of the weight striking the bottom, the effect of drift or currents, and the great loss of velocity in the descent, requiring so much time for a single cast, are therefore difficulties which cannot be overcome by this mode of sounding, and there is a limit at two or three thousand fathoms depth, beyond which the method practically fails; and even at less depths large errors must enter into the results.

The effect of increasing the specific gravity of the line, as in making use of wire, is unfavorable, since at a certain depth the weight of the wire alone must overcome the resistance offered by the water, and it would run out of its own weight. The depth at which this would occur for a wire seven-hundredths of an inch in diameter is about 1,700 fathoms; and for a wire three-tenths of an inch in diameter, 400 fathoms.

The same difficulty occurs when a large hempen line is used. A line two inches in diameter of this material would run out of its own weight with a velocity of three feet per second at the depth of 1,900 fathoms. An instance of this kind is given in the experiment of Lieut. Joseph Dayman, R. N., in sounding across the Atlantic in 1857.

Table (IX) gives the results of the experiment referred to; when the line was hauled in 200 fathoms of it were coiled upon the sinker, the latter having struck bottom at 2,200 fathoms.

The next consideration is the mode of noting or measuring the depth within the limits which are accessible. For this purpose several plans have been followed, none of which have been so successful that the degree of accuracy attained or the probable error of the determination might be estimated.

The most natural method is to measure the length of the line paid out. The errors arising from the drifting of the vessel, and currents acting upon a long length of line in the water, may in this case amount to as much as one-fourth of the depth; and the method has accordingly been rejected entirely where there is any current or drift. Computing the depth from the time and rate of descent is another mode which, in the manner in which it has been applied, is unreliable, especially on account of the difficulty of noting the exact instant when the sinker strikes the bottom.

The most successful plan, thus far, is to attach a self-registering indicator to the weight, the indicator being brought back to the surface and the weight detached at the bottom.

The indicator heretofore used is known as "Massey's Indicator," and although theoretically well adapted to the purpose to which it is applied, yet, on account of faults in its construction the results obtained by its use at great depths have not been satisfactory, and, in fact, are little more value than the determinations by the length of line paid out. In the soundings across the Atlantic in 1857, Lieut. Comg. Dayman rejects the determinations by the indicator, after numerous experiments to ascertain what he called its "index errors." The difficulty seems to be in the small surface given to the helix, the great size of the axis upon which the helices are placed, the friction of the wheel work, and, generally, the clumsy construction of the machine, which prevents the helix from revolving with equal facility at all velocities. The comparisons made by Lieut. Dayman show that different machines attached to the same sounding weight will give very different indications, and the same machine will give different indications when attached to different weights and different lines.

The "Current Indicator," invented by Mr. Joseph Saxton, of the office of weights and measures, might, by very slight modifications, be applied to the purpose of sounding, and would be in every respect superior to Massey's.

With all its imperfections, however, Massey's indicator furnishes better results, when carefully used, than the method of measuring the depth by the line out, and for this reason I think the soundings of Lieut. Berryman, where he used the indicator on the line of the Atlantic telegraph, are much nearer the truth than those of Lieut. Dayman.

In both cases the probable errors are very large, amounting in many instances, I think, to several hundred fathoms.

The idea of a "plateau" existing between Newfoundland and Ireland is not warranted, it seems to me, by any observations that have yet been made. The range of errors may be as great as 500 fathoms, which would admit of the existence of a submarine mountain on this line half as high as Mount Washington. A true section of the Atlantic can only be determined by improved modes of sounding, since, from the preceding discussion, we may be warranted in the conclusion that it is practically impossible to determine the greatest depths of the ocean by the methods now in use.

I.

Table showing the rates of descent and resistance in pounds upon the sinker and line in sounding with one and two 32-pound shot attached to a line $\frac{7}{100}$ of an inch in diameter.

Depth.	One 32-pound shot.					Two 32-pound shot.				
	No. of casts.	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.	No. of casts.	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.
Fathoms.		*Min. Sec.*	*Feet.*	*Pounds.*	*Pounds.*		*Min. Sec.*	*Feet.*	*Pounds.*	*Pounds.*
0			16.41	27.36					54.72	
50			8.83	8.15	19.15			12.50	32.70	22.02
100		1 08					0 48			
150			6.66	4.64	22.72			9.40	18.49	36.23
200		1 30					1 04			
250			5.41	3.06	24.30			7.32	11.21	43.51
300	29	1 51				27	1 22			
350			4.65	2.26	25.10			6.45	8.70	46.02
400	29	2 09				28	1 33			
450			4.14	1.81	25.55			5.61	6.58	48.14
500	29	2 25				28	1 47			
550			3.77	1.50	25.86			5.36	6.01	48.71
600	29	2 39				28	1 52			
650			3.55	1.33	26.03			4.81	4.98	49.74
700	27	2 49				22	2 03			
750			3.37	1.20	26.16			4.76	4.85	49.87
800	26	2 58				18	2 06			
850			3.11	1.02	26.34			4.48	4.30	50.42
900	27	3 13				16	2 14			
950			2.94	.91	26.45			4.23	3.83	50.89
1,000	26	3 24				16	2 22			
1,050			2.84	.85	26.51			4.03	3.48	51.24
1,100	22	3 31				16	2 29			
1,150			2.66	.75	26.65			3.85	3.17	51.55
1,200	21	3 45				14	2 36			
1,250			2.66	.75	26.65			3.73	2.98	51.74
1,300	19	3 45				11	2 41			
1,350			2.53	.68	26.68			3.45	2.55	52.17
1,400	18	3 57				11	2 54			
1,450			2.43	.62	26.74			3.44	2.53	52.19
1,500	19	4 07				11	2 56			
1,550			2.37	.59	26.77			3.26	2.28	52.44
1,600	17	4 13				10	3 04			
1,650			2.31	.56	26.80			3.23	2.23	52.49
1,700	17	4 20				8	3 06			
1,750			2.25	.53	26.83			3.19	2.18	52.54
1,800	17	4 26				7	3 08			
1,850			2.21	.51	26.85			3.08	2.03	52.69

I—Continued.

Depth.	One 32-pound shot.						Two 32-pound shot.					
	No. of casts.	Intervals of times of descent.		Velocity.	Resistance to sinker.	Resistance to line.	No. of casts.	Intervals of times of descent.		Velocity.	Resistance to sinker.	Resistance to line.
Fathoms.		*Min.*	*Sec.*	*Feet.*	*Pounds.*	*Pounds.*		*Min.*	*Sec.*	*Feet.*	*Pounds.*	*Pounds.*
1,900	15	4	31				7	3	15			
1,950				2.15	.48	26.88				3.06	2.00	52.72
2,000	12	4	39				5	3	16			
2,050				2.09	.44	26.92				2.99	1.91	52.81
2,100	8	4	47				5	3	21			
2,150				2.08	.43	26.93				2.93	1.84	52.88
2,200	6	4	48				3	3	25			
2,250				2.04	.41	26.95				2.84	1.73	52.99
2,300	5	4	54				2	3	31			
2,350				1.91						2.83	1.71	53.01
2,400	4	5	13				2	3	32			
2,450				1.99						2.67	1.53	53.19
2,500	4	5	01				2	3	45			
2,550	[*]		[*]	2.03					[*]	2.69	1.55	53.17
2,600	3	4	56				1	3	43			
2,650				1.83								
2,700	3	5	27									
2,750				2.22								
2,800	1	4	30									
2,850				2.11								
2,900	1	4	44									
2,950				2.14								
3,000	1	4	40									

[*] In every instance the intervals became irregular and unreliable below 2,500 fathoms.

II.

Table showing the rates of descent and resistances in pounds upon the sinker and line in sounding with 96 and 126-pound weights attached to a deep-sea line $\frac{4}{10}$ths of an inch in diameter.

Depth.	96-pound weight, deep-sea line.				126-pound weight, deep-sea line.			
	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.
Fathoms.	*Min. sec.*	*Feet.*	*Pounds.*	*Pounds.*	*Min. sec.*	*Feet.*	*Pounds.*	*Pounds.*
0		27.26	82.03			26.99	106.26	
50		11.54	14.39	67.64		13.93	29.24	80.02
100	0 52				0 43			
150		7.41	6.08	75.95		8.44	10.68	98.58
200	1 21				1 11			
250		5.94	3.91	78.12		6.82	6.97	102.29
300	1 41				1 28			
350		5.17	2.96	79.07		5.60	4.70	104.56
400	1 56				1 47			
450		4.69	2.44	79.59		5.31	4.29	104.97
500	2 08				1 53			
550		4.35	2.10	79.93		5.04	3.81	105.45
600	2 18				1 59			
650		4.11	1.87	80.16		4.89	3.59	105.67
700	2 26				2 05			
750		3.89	1.64	80.39		4.48	3.10	106.16
800	2 34				2 14			
850		3.73	1.54	80.49		3.98	2.38	106.88
900	2 41				2 31			
950		3.61	1.44	80.59		4.19	2.65	106.61
1,000	2 46				2 23			
1,050		3.47	1.33	80.70		3.98	2.38	106.88
1,100	2 53				2 30			
1,150		3.37	1.26	80.77		4.05	2.44	106.82
1,200	2 58				2 28			
1,250		3.33	1.23	80.80		3.92	2.29	106.97
1,300	3 00				2 33			
1,350		3.37	1.27	80.76		3.87	2.23	107.03
1,400	2 58				2 35			
1,450		3.24	1.17	80.86		3.61	1.94	107.32
1,500	3 05				2 46			
1,550		3.11	1.08	80.95		3.53	1.85	107.41
1,600	3 13				2 50			
1,650		3.00	1.00	81.03		3.41	1.72	107.54
1,700	3 16				2 56			
1,750		2.90	.93	81.10				
1,800	3 16							
1,850		2.80	.87	81.16				

II.—Continued.

Depth.	96-pound weight, deep-sea line.				126-pound weight, deep-sea line.			
	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.
Fathoms.	*Min. sec.*	*Feet.*	*Pounds.*	*Pounds.*	*Min. sec.*	*Feet.*	*Pounds.*	*Pounds.*
1,900	3 27							
1,950		2.70	.81	81.22				
2,000	3 43							
2,050		2.70	.81	81.22				
2,100	3 43							
2,150		2.47	.68	81.35				
2,200	4 03							

V.

Table showing velocities and resistances at different depths, and comparisons of squares of velocities to resistances. Observations made with one and two 32-pound shot. Small line.

Depth.	One 32-pound shot.		Two 32-pound shot.		Ratios of squares of velocities.	Ratios of resistances to lines.
	Velocity.	Resistance to line.	Velocity.	Resistance to line.		
Fathoms.	*Feet.*	*Pounds.*	*Feet.*	*Pounds.*		
0	16.41		16.41		1.000	
50	8.83	19.15	12.50	22.02	2.004	1.150
150	6.66	22.72	9.40	36.23	1.992	1.595
250	5.41	24.30	7.32	43.51	1.831	1.790
350	4.65	25.10	6.45	46.02	1.924	1.833
450	4.14	25.55	5.61	48.14	1.843	1.884
550	3.77	25.81	5.36	48.71	2.021	1.887
650	3.55	26.03	4.88	49.74	1.890	1.911
750	3.37	26.16	4.76	49.87	1.995	1.906
850	3.11	26.34	4.48	50.42	2.084	1.914
950	2.94	26.45	4.23	50.89	2.070	1.924
1,050	2.84	26.51	4.03	51.24	2.014	1.933
1,150	2.66	26.65	3.85	51.55	2.095	1.934
1,250	2.66	26.65	3.73	51.74	1.966	1.941
1,350	2.53	26.68	3.45	52.17	1.859	1.911
1,450	2.43	26.74	3.44	52.19	2.004	1.907
1,550	2.37	26.77	3.26	52.44	1.892	1.914

IV.

Table showing velocities and resistances at different depths and comparisons of squares of velocities to resistances. Observations made with 96 and 126-pound weights. Deep-sea line.

Depth.	96-pound weight.		126-pound weight.		Ratios of squares of velocities.	Ratios of resistances to lines.
	Velocity.	Resistance to line.	Velocity.	Resistance to line.		
Fathoms.	*Feet.*	*Pounds.*	*Feet.*	*Pounds.*		
0	27.26	--------	26.99	--------	--------	--------
50	11.54	67.64	13.93	80.02	1.457	1.183
150	7.41	75.95	8.44	98.58	1.297	1.298
250	5.94	78.12	6.82	102.29	1.318	1.310
350	5.17	79.07	5.60	104.56	1.173	1.322
450	4.69	79.59	5.31	104.97	1.282	1.319
550	4.35	79.93	5.04	105.45	1.342	1.319
650	4.11	80.16	4.89	105.67	1.414	1.318
750	3.89	80.39	4.48	106.16	1.326	1.321
850	3.73	80.49	3.98	106.88	1.138	1.328
950	3.61	80.59	4.19	106.61	1.347	1.323
1,050	3.47	80.70	3.98	106.88	1.316	1.325
1,150	3.37	80.77	4.05	106.82	1.444	1.322

III.

Table showing influence of different lengths of line moving with the same velocity. Ratios of length to ratio of resistances.

Velocity.	Depth.		R.	R¹.	Ratio of lengths.	R¹.R.	Depth.		R.	R¹.	Ratio of lengths.	R¹.R.
	1 32-pound shot.	2 32-pound shot.	1 32-pound shot.	2 32-pound shot.			96-pound weight.	126-pound weight.	96-pound weight.	126-pound weight.		
Feet.	*Fathoms.*	*Fathoms.*	*Pounds.*	*Pounds.*			*Fathoms.*	*Fathoms.*	*Pounds.*	*Pounds.*		
8.0	70	200	--------	--------	2.857	--------	120	175	--------	--------	1.458	--------
7.5	100	220	--------	--------	2.200	--------	140	200	71.6	96.8	1.428	1.352
7.0	120	280	--------	--------	2.325	--------	170	240	73.8	100.0	1.411	1.355
6.5	150	340	21.7	47.6	2.266	2.193	200	280	75.2	101.5	1.400	1.350
6.0	190	420	23.2	48.5	2.211	2.090	240	330	76.6	102.7	1.375	1.341
5.5	230	510	24.5	49.3	2.217	2.012	300	400	77.8	103.9	1.333	1.336
5.0	290	640	25.7	50.0	2.206	1.945	380	500	78.8	104.9	1.315	1.331
4.5	350	820	26.7	50.8	2.342	1.902	520	660	79.6	105.7	1.269	1.328
4.0	480	1,080	28.2	51.8	2.250	1.837	710	880	80.2	106.5	1.239	1.328
3.5	650	1,400	29.7	52.4	2.153	1.764	1,080	1,340	80.7	107.2	1.240	1.328
3.0	880	1,900	31.3	--------	2.159	--------	1,650	--------	81.2	--------	--------	--------

VII.

Comparison of resistances upon the same lengths of lines of different diameters, moving at the same velocity.

Velocity.	DEEP-SEA LINE. Depth. 96-pound weight.	DEEP-SEA LINE. R.	DEEP-SEA LINE. Resistance upon one fathom.	SMALL LINE. Depth. 1 32-pound shot.	SMALL LINE. R.	SMALL LINE. Resistance upon one fathom.
Feet.	*Fathoms.*	*Pounds.*	*Pounds.*	*Fathoms.*	*Pounds.*	*Pounds.*
8.0	120	------	------	70	------	------
7.5	140	71.6	------	100	------	------
7.0	170	73.8	------	120	------	------
6.5	200	75.2	0.3765	150	21.7	0.144
6.0	240	76.6	0.3191	190	23.2	0.122
5.5	300	77.8	0.2593	230	24.5	0.106
5.0	380	78.8	0.2073	290	25.7	0.088
4.5	520	79.6	0.1530	350	26.7	0.076
4.0	710	80.2	0.1129	480	28.2	0.058
3.5	1,080	80.7	0.0747	650	29.7	0.045
3.0	1,650	81.2	0.0492	880	31.3	0.035

VI.

Table showing influence of lengths at different depths.

Velocity.	Depth. 1 32-pound shot.	Depth. 2 32-pound shot.	Difference.	R^1. R.	R.	Ratio of lengths.	Ratio of resistances.	Depth. 96-pound weight.	Depth. 126-pound weight.	Difference.	R^1. R.	R.	Ratio of lengths.	Ratio of resistances.
Feet.	*Fath.*	*Fath.*	*Fath.*	*Pounds.*	*Pounds.*			*Fath.*	*Fath.*	*Fath.*	*Pounds.*	*Pounds.*		
8.0	70	200	------	------	------	------	------	120	175	------	------	------	------	------
7.5	100	220	------	------	------	------	------	140	200	------	25.2	71.6	------	2.841
7.0	120	280	------	------	------	------	------	170	240	------	26.2	73.8	------	2.817
6.5	150	340	190	25.9	21.7	------	------	200	280	80	26.3	75.2	2.50	2.859
6.0	190	420	230	25.3	23.2	1.211	1.090	240	330	90	26.1	76.6	2.66	2.938
5.5	230	510	280	24.8	24.5	1.217	1.012	300	400	100	26.1	77.8	3.00	2.981
5.0	290	640	350	25.3	25.7	1.207	0.984	380	500	120	26.1	78.8	3.17	3.019
4.5	350	820	470	24.1	26.7	1.343	0.903	520	660	140	26.1	79.6	3.71	3.049
4.0	480	1,080	600	23.6	28.2	1.250	0.837	710	880	170	26.3	80.2	4.18	3.072
3.5	650	1,400	750	22.7	29.7	------	0.764	1,080	1,340	260	26.5	80.7	4.16	3.045
3.0	880	1,900	1,020	------	31.3	------	------	1,650	------	------	------	81.2	------	------

VIII.—*Table showing influence of lengths at different depths.*

Velocity.	Depth. 1 32-pound shot.	Depth. 2 32-pound shot.	Difference.	R^{1}. R.	R.	Ratio of lengths.	Ratio of resistances.	Depth. 96-pound weight.	Depth. 126-pound weight.	Difference.	R^{1}. R.	R.	Ratio of lengths.	Ratio of resistances.
Feet.	*Fath.*	*Fath.*	*Fath.*	*Pounds.*	*Pounds.*			*Fath.*	*Fath.*	*Fath.*	*Pounds.*	*Pounds.*		
8.0	70	200	------	------	------	------	------	120	175	------	------	------	------	------
7.5	100	220	------	------	------	------	------	140	200	------	------	96.8	------	------
7.0	120	280	------	------	------	------	------	170	240	------	------	100.0	------	------
6.5	150	340	190	25.9	47.6	1.789	1.838	200	280	80	26.2	101.5	3.500	3.874
6.0	190	420	230	25.3	48.5	1.826	1.917	240	330	90	26.1	102.7	3.666	3.935
5.5	230	510	280	24.8	49.3	1.821	1.988	300	400	100	26.1	103.9	4.000	3.981
5.0	290	640	350	25.3	50.0	1.829	1.976	380	500	120	26.3	104.9	4.166	3.988
4.5	350	820	470	24.1	50.8	1.745	2.108	520	660	140	26.1	105.7	4.714	4,049
4.0	480	1,080	600	23.6	51.8	1.800	2.195	710	880	170	26.3	106.5	5.176	4,049
3.5	650	1,400	750	22.7	52.4	1.866	2.308	1,080	1,340	260	26.3	107.2	5.154	4.076
3.0	880	1,900	1,020	------	------	------	------	1,650	------	------	------	------	------	------

IX.—*Table showing the rates of descent, velocity, resistance to sinker and line, and weight of line in water, from observations made by Lieut. Comg. Joseph Dayman, R. N. Diameter of line, 2 inches. Weight,* 96 *pounds. Specific gravity,* 1.3.

Depth.	Intervals of times of descent.	Velocity.	Resistance to sinker.	Resistance to line.	Weight of line in water.	Remarks.
Fathoms.	*m. s.*	*Feet.*	*Pounds.*	*Pounds.*	*Pounds.*	
0	------	27.26	82.0	------	------	On bringing the apparatus back to the surface after 2,400 fathoms had run out, 200 fathoms of line was found coiled upon the sinker. The depth was probably not greater than 2,000 fathoms.
100	1 24	7.14	5.62	100.6	23	
200	1 17	4.35	4.33	119.4	46	
300	2 01	------	------	138.1	69	
400	2 07	------	------	156.8	92	
500	2 20	------	------	175.5	115	
600	2 18	------	------	194.2	138	
700	------	------	------	212.9	161	
800	------	------	------	231.6	184	
900	------	------	------	250.3	207	
1,000	------	------	------	269.0	230	
1,100	------	------	------	287.7	253	
1,200	------	------	------	296.4	276	
1,300	------	------	------	325.1	299	
1,400	------	------	------	343.8	322	
1,500	------	------	------	362.5	345	
1,600	------	------	------	381.2	368	
1,700	------	------	------	399.9	391	
1,800	------	------	------	418.6	414	
1,900	------	------	------	437.3	437	

APPENDIX No. 38.

Apparatus for harbor soundings, proposed by Lieut. E. B. Hunt, and constructed for the use of the United States Coast Survey.

Boston, *October* 12, 1858.

Dear Sir: In accordance with your instructions I have made various observations with the apparatus for harbor soundings.

This instrument is intended for running lines of soundings in harbors and water of moderate depth. The principle is that of measuring barometrically the pressure due to the depth, this pressure being transmitted to a manometer or pressure indicator by a column of atmospheric air. This is effected by means of an elastic bag filled with air, which is dragged upon the bottom, and is connected by a flexible air-tight tube with the manometer, which is placed in a boat or surveying vessel, where the variations of pressure shown by the index are observed and recorded.

The India rubber air-vessel, when distended, contains about six gallons of air; it is pear-shaped, and is enclosed in a metallic case of the same form, so that it may offer little resistance when passing through the water, the case being of sufficient weight to sink the air-vessel. The tube is made of three layers of vulcanized India rubber, canvas being used in the central layer to give greater strength; its diameter is six-tenths of an inch, with a bore of two-tenths; it is firmly attached to the neck of the air-bag, from which it extends to the manometer, and is secured to it by an air-tight union coupling. This instrument, which shows the amount of pressure per square inch, is known as Bourdon's steam-gauge, (Ashcrofts' patent,) the common graduation in pounds being changed to feet and fathoms. If used in sea water the pressure per square inch is 0.4455 pound at a depth of one foot, and 2.67 pounds upon the dial is marked one fathom, the length of each fathom division being about one inch, so that fractions of feet are easily read.

The length of the India rubber tube is one hundred and fifty feet, which is sufficient for a depth of about eight fathoms. To prevent excess of strain upon the tube, a drag-rope is lashed to it at intervals, and secured at one end to the neck of the air-case, the other end being made fast to the boat.

When the apparatus is to be used the air-bag is inflated and the stop-cock at the opposite end of the tube is closed; it is then screwed fast to the pressure-gauge and the stop-cock opened; the bag is lowered to the bottom by means of the drag-rope, and the pressure-gauge placed in any convenient position in the boat, which is then rowed in the direction of the line upon which soundings are to be made. As the air-vessel rises and falls, following the curvature of the bottom, the index of the manometer shows the pressure, in pounds, upon each square inch, and the depth in feet or fathoms, which being recorded at regular intervals gives a perfect outline or profile upon the line traversed. The continuous indication of depth given by this instrument becomes an important feature when it is used in dragging for bars or shoals along channel ways.

With one hundred feet of tube attached the instrument is so sensitive that a change in the depth of immersion to the extent of an inch is shown by the index.

The escape of a large part of the air from the bag does not diminish the pressure upon the manometer, the exact pressure due to the depth being indicated so long as any air remains in the air-vessel.

As the air-vessel cannot be in actual contact with the bottom, the manometer indicates a few inches less than the actual depth; it is therefore necessary, when observations are commenced, to determine the amount of correction by sinking the bag in any known depth of water and noting the difference between this and the index reading.

The apparatus can be used to advantage as a *sounding instrument* on a bottom that is free from abrupt obstructions, and as a *tide meter* on board a vessel or at the shore. In all the soundings made the position of the index corresponds precisely with the depths given by the lead and line. Its use as a tide meter on board the Coast Survey steamer Bibb is stated by Lieut. Comg. Murray as being very satisfactory, and that officer suggests that if this instrument is provided for the vessels of the Coast Survey it will not be necessary to station observers on the shore to record the height of the tide.* The bag, enclosed in a case, was lowered to the bottom, the rubber tube brought in at one of the side lights, and the pressure-gauge suspended above the cabin table. When the vessel is lying at anchor the state of the tide is known *on board* at any moment, the position of the index having been once compared with mean low water, and this reading deducted from each subsequent observation.

It is often difficult to find a suitable place for the tide-staff, and this, together with the expense of keeping an attendant on shore, may perhaps render it advisable to adopt this mode of making tidal observations.

On account of the lateness of the season I have been unable to comply with your orders relative to observations for the determination of the height of the tide-wave at a distance from the shore. During the calm weather of the next season this can readily be done on the seaward side of George's shoal, or at such other point as you may designate.

I am, very respectfully, your obedient servant,

JOHN M. BATCHELDER.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 39.

Report of Assistant L. F. Pourtales on the progress made in the microscopical examination of specimens of bottom from deep-sea soundings.

COAST SURVEY OFFICE, *October* 28, 1858.

SIR: I beg to submit the following report on the progress made in the examination of the specimens of sea-bottom and of the organic remains which they contain, with which you have entrusted me.

In a communication to you, dated September 10, 1856, I had laid out the principal points I intended to take up. I did very little, however, until the autumn of 1857, owing, chiefly, to the want of books of reference and my consequent ignorance of what had been done in this branch of late years in Europe. At that time I visited Cambridge, where Professor Agassiz' fine library and kind advice afforded me an opportunity of becoming acquainted with the recent works of the principal foreign microscopists. Very valuable information was also obtained from

* A reference mark of a fixed character will still be needed, for obvious reasons.—A. D. B.

the collections of the late Professor J. W. Bailey, of West Point, bequeathed by him to the Boston Society of Natural History, and I was permitted to select from the rough material left by him for distribution more than 250 specimens of sea bottoms, sedimentary rocks, soils, and infusorial earths, from all parts of the world, and all containing microscopical organic remains, which will be of great utility for comparison and for affording standard forms. Since my return I have devoted a part of my time to the study of our specimens, by means of the fine Spencer microscope belonging to the Smithsonian Institution, and kindly loaned to me by Professor Henry.

The principal object of my investigations has been the Foraminiferae or Polythalamia, the minute shells of which cover the bottom of the ocean, sometimes to such an extent as to exclude any other material. Notwithstanding the important part which these small beings have played in geological ages, and are still playing at the present day, modifying and increasing the crust of our globe in a manner probably still more extensive than the corals, they are yet but very imperfectly known. Much as has been written on the subject in late years by careful zoological investigators, our knowledge of their organization, reproduction, and even their rank in the zoological scale, is unsatisfactory, so much so that doubts are expressed by a very high authority as to whether they belong to the animal or vegetable kingdoms.

The abundant material contained in the collection of specimens of sea bottom made during the progress of the survey makes me hope to be able to solve some of these questions, as well as those connected with the interesting and complicated structure of the shell, the curious mathematical relations in the succession of the cells, the geographical distribution, the distribution according to depth, &c.

During the last winter I had made arrangements to receive the specimens preserved in sea water as early as possible after having been collected, hoping to be thus enabled to observe the Foraminiferae alive. They have been found by some observers to bear transportation very well and to live a long time in captivity. Accordingly specimens were received from Commander B. F. Sands and Lieutenant W. G. Temple, U. S. N., and Mr. Gustavus Würdemann. I was, however, disappointed in all but one doubtful instance, although some small molluscs were found alive in the same water, and remained so for some time. The specimens were, however, well worth the trouble, adding many new species to the collection.

By your direction I examined the specimens obtained by Commander Sands in carrying a line of soundings between the Tortugas and Havana. They all consist of a gray mud, becoming more dark as the soundings approach the coast of Cuba. A few new Foraminiferae were found in it, but the greater part were the usual species found in the Gulf Stream soundings.

In making preparations for illustrating the structure of the shell of Orbulina universa, the curious fact was discovered that many of the specimens contained a young Globigerina more or less developed, so that these two genera must be considered as one only, the two forms being probably but two stages of alternate generations. Numerous preparations were made and preserved to illustrate the different stages of development, and a short notice of the fact was communicated with your permission to the American Journal of Science and Art, and published in its number for July of this year.

The fine collection of specimens obtained in the Gulf Stream by Commander Sands in 1857, afforded another interesting subject of study. My attention was particularly called to some of them brought up off the coast of South Carolina, which consisted almost entirely of *green sand*, which, as has been discovered a few years ago by Baily, is produced by an incrustation of the cells of Foraminiferae by a silicate of iron, leaving, after the decomposition of the calcareous shell, a most beautiful inside cast of the cells and their connecting tubes, and even of the most delicate ramifications of minute canals in the substance of the shell. Such casts fill the so called marls, used as fertilizers in New Jersey, rotten lime-stone, and numerous other formations of the chalk and tertiary periods underlying so large a part of our southern States. The specimens in question present a beautiful example of the successive transformations. By the side of the most fresh-looking Foraminiferae, of various species, are found specimens having a yellowish appearance, which, on being opened, are found to be filled with an opaque ochraceous substance. In more advanced ones this substance turns greenish, the shell at the same time becoming full of cracks, and dropping off piecemeal; next we find the nucleus freed of all trace of shell, at first greenish, but becoming afterwards black and polished, and conglomerating into smooth black pebbles. All trace of their origin seems then lost, but on grinding and polishing one of those pebbles into a thin plate, transparent enough to be viewed under the microscope by transmitted light, the spiral succession of cells of the Foraminiferae is plainly to be recognized. Foraminiferae, although forming the majority of those casts, are, however, not the only source from which they are derived. The cavities of small molluscs, milleporae, the canals in the shells of barnacles (Balanus) are found partly filled with the same substance. The subject will be pursued, and the preparations compared with the green sand marls of Mississippi, for a valuable collection of which I am indebted to Dr. E. W. Hilgard, State geologist.

It is remarkable that in many localities of our southern coast, in moderate depths, the dead shells which abound in the soundings undergo a change from white to yellow, then to brown or dark gray, and finally to a glossy black. Their small fragments in that state form the black specks so commonly mixed with the white quartz sand. My attention was first called to this fact by Dr. A. A. Gould, of Boston. Here it is, however, the substance of the shell which undergoes a change, whilst in the Foraminiferae it is a foreign substance filling up the cavities. The black grains formed by the latter process are readily distinguished from those formed from shells. These are harder and smooth, the others softer and kidney-shaped.

Numerous preparations of all the above described objects have been mounted for the microscope, and a few of them drawn. I was in hope at one time that they might be reproduced by photography, experiments having been made by Mr. C. A. Schott; but although he succeeded very well with the smaller microscopical objects, the comparatively great thickness of the Foraminiferae and their high relief prevents the whole of a specimen being brought into one focus of the microscope, so that only small portions can be seen at once. I am very desirous to have them reproduced by a good draughtsman. My own attempts have resulted in too great a loss of time with too little artistic attainments.

In concluding, I would remark that my investigations bear as yet a very desultory appearance. This is scarcely to be avoided, as I have confined myself to collecting facts, pursuing new ones when they presented themselves collaterally, and deferring generalities until I shall have accumulated a good basis of observations to stand upon.

Very respectfully, your obedient servant,

L. F. POURTALES.

Prof. A. D. BACHE, LL.D.,

Superintendent U. S. Coast Survey.

APPENDIX No. 40.

Review by Professor W. P. Trowbridge, Assistant in the Coast Survey, relating to the origin, cost, and progress of foreign geodetic surveys, with other data for comparison with the results of the United States Coast Survey.

TRIGONOMETRICAL SURVEYS OF ENGLAND, IRELAND, AND SCOTLAND.

ENGLAND.

The trigonometrical survey of England had its origin in the operations for determining the difference of longitude between the observatories of London and Paris, according to a plan suggested by Cassini de Thury in a memoir published in Paris in 1783. This memoir set forth the great advantages which would result to astronomy by carrying a series of triangles from the neighborhood of London to Dover, there to be connected with those already executed in France, by which combined operations the relative situations of the two most famous observatories in the world, Greenwich and Paris, would be more accurately ascertained.

The work was executed under the direction of the Royal Society by Major General Roy, F. R. S.; the first base being measured on Hounslow Heath, and a base of verification being measured on Romney Marsh. In 1791 the actual survey of the kingdom was commenced upon the basis of the triangulation already executed. The base on Hounslow Heath was remeasured, and the triangulation continued under the charge of Lieutenant Colonel Williams and Captain Mudge, of the royal artillery, and Mr. Isaac Dalby, from 1791 to 1799. From 1800 to 1809 the survey was continued under the direction of Lieut. Col. William Mudge and Captain Thomas Colby; during this period the principal triangulation was extended over nearly the whole of England and Wales and a part of Scotland. The number of stations or primary points was about 200; one to 300 square miles, the lines varying from ten to fifty miles in length.

Upon the basis of this triangulation it was determined to construct a map of England consisting of 108 sheets, on a scale of one inch to the mile, or $\frac{1}{63360}$. The execution of the work was assigned to the Ordnance department, and carried on by officers of the royal engineers sappers and civilians combined, under the direction of Colonel Colby.

The state of the survey in 1835 is shown in the following extract from a memorial of the British Association for the Advancement of Science, published in 1835:

"The trigonometrical survey of England commenced in 1791; of the 108 sheets required for the whole map 65 only have been published; at which rate it will require thirty years to complete the survey to the banks of the Tweed. Urgent calls for this work are made by the proprietors of lands, mines, &c.; and another important benefit to be conferred is the correction of the Coast Surveys by determining the precise position of headlands. As an illustration of this, it may be remarked that errors in the most accredited charts of the northern coast have been detected to an extent, in one instance, of eleven miles."

The total area of England and Wales is 60,000 square miles, and it is now sixty-six years since the trigonometrical survey was first commenced. Eight sheets of the one hundred and eight, on the one-inch scale, remain to be finished. The total expenditures for the survey, from 1791 to 1856, was £993,514 sterling, or nearly five millions of dollars. This expenditure does not include any expenditure for the hydrographic survey of the coast, the trifling amount of £250 only having been expended in the fixation of points for the hydrographic parties.

The total cost to complete the survey from the beginning was estimated by Colonel Colby at £1,500,000, or seven and a half millions of dollars. More recent estimates state that over £2,000,000 will be required, or about $10,500,000.*

The cost per square mile of the English survey, including field-work, engraving, publishing, &c., is £30, or 9*d.* to 12*d.* per acre; for the one-inch scale the cost is 9¼*d.*, and for the 25-inch scale, used in certain districts, 12*d.* The number of officers and sappers, civilians, &c., employed on the survey for the years 1842, 1843, 1844, and 1846, is shown in the following table:

1842—16 officers, 152 sappers, 517 civil assistants, 379 laborers.
1843—16 . . do . . . 246 . . . do . . . 773 . . . . do . . . . 560 . . . do.
1844—11 . . . do . . . 226 . . . do . . . 556 . . . . do . . . . 268 . . . do.
1846— 8 . . . do . . . 181 . . . do . . . 265 . . . . do . . . . 147 . . . do.

These statements show the average number of persons employed each year on the survey of England alone.

The number of sheets of different parts of England sold, from 1825 to 1846, was 92,711, at 5*s.* and 2*s.* 6*d.* each.†

IRELAND.

The survey of Ireland was commenced in 1824, under the direction of General Colby, and the principal triangulation was finished in 1842. The connected triangulation of England, Ireland, and Scotland, was finished in 1846.

In the year 1846 the complete survey of Ireland was finished, on a scale of six inches to a mile, and the maps of thirty-one counties published. Plans of one hundred and twenty-six principal towns, on a larger scale, were completed; for the scale of one inch to a mile the field-work for thirteen counties had been completed. In 1844 a revision of the maps of the northern counties was ordered, the whole of which, with the original survey, are now completed and published. The cost of the survey of Ireland from 1824 to 1846 was £749,117; the total cost up to 1856, including the revision, was £1,077,240 sterling, or about five millions three hundred thousand dollars.

The total cost of the surveys of England and Ireland to 1856 was about $10,000,000. The area of Ireland is about 30,000 square miles. The number of officers of engineers, royal sappers, civil assistants, &c., employed on the Irish survey during the years 1838, 1839, and 1840, is given in the following table:

1838.—Officers, 22;	sappers, 212;	civil assistants, 892;	laborers, 923.	
1839. " 22;	" 212;	" 892;	" 923.	
1840. " 22;	" 212;	" 892;	" 923, nearly.	

The number of copies of maps of the Irish surveys sold up to 1846 was 119,000, at 5*s.* and 2*s.* 6*d.* each.

The expenses of engraving and printing the Irish survey, from 1826 to 1846, amounted to £78,784, equal to $393,920.‡

* British Par. Doc. 1851.
† Brit. Par. Doc., Colby's Survey, &c.
‡ British Par. Doc.

SCOTLAND.

The following extract from a memorial of the Royal Scottish Society of Arts, May, 1844, shows the state of the survey of Scotland at that time: "From a return lately furnished by the Board of Ordnance it appears that the principal triangulation of the survey was commenced in 1809, and although the principal triangulation is so far advanced as to admit of progress being made in the detailed survey and the secondary triangulation, it appears that no part of either of them has been commenced, with the exception of a small portion of the secondary triangulation along a part of the western coast."

In 1846 the secondary triangulation of only two counties was completed. It is stated in the London Geographical Journal for 1856 that the survey of Scotland is now progressing more rapidly, with a prospect of its being completed in a few years.

The total expenditures of the survey of Scotland up to the year 1856 amounted to £283,688, or $1,418,440.

In the years 1844, 1845, and 1846, there were employed on this survey officers and sappers, &c., as follows:

1844.—Officers of engineers,	2;	sappers, 10;	civil assistants, 42;	laborers, 59.
1845. " "	2;	" 27;	" 55;	" 43.
1846. " "	1;	" 36;	" 54;	" 63.

It is estimated that £917,500 will be required to finish the survey.*

From the foregoing it will be seen that the surveys of the United Kingdom of Great Britain and Ireland have occupied nearly seventy years.

The total area of the United Kingdom is 120,000 square miles. The total cost of the surveys up to 1856 was nearly twelve millions of dollars. The number of persons engaged in the survey of England at one time (year 1843) was fifteen hundred and ninety-five; on the survey of Ireland the number engaged in the year 1840 was two thousand and forty-nine; and on the survey of Scotland one hundred and thirteen, making a total of about three thousand five hundred persons engaged on the English survey at one time.

It is estimated that to complete the surveys according to the plans proposed the total cost will be—

For England	£2,138,265
For Ireland	1,077,240
For Scotland	917,500
	4,133,005, or $20,665,000.†

In addition to the surveys of the United Kingdom, the English are carrying on trigonometrical surveys in Australia, Tasmania, Ceylon, Mauritius, and India, under the direction of the royal engineers. In 1848 an expedition was sent to the Cape of Good Hope to remeasure the arc of meridian measured by La Caille in 1751. A new base was measured and a chain of triangles carried along the coast for three hundred miles, which has since formed the basis for an accurate map of the coast, seventy miles of which have been completed.‡

* British Par. Doc.

† British Par. Doc. 1851.

‡ The length of coast-line of England, Ireland, and Scotland is equal to 4,410 miles.

THE HYDROGRAPHY OF ENGLAND.

The hydrographical labors of the English have been more extensive than those of any other nation on the globe. She has sent no less than fifty expeditions to the Arctic seas, and has vessels continually engaged in different parts of the world, and yet, for want of a proper system of co-operation with the ordnance survey, the charts of the coasts of the United Kingdom are far from being accurate or complete.

The following table shows the amounts expended by the Admiralty in each year for hydrographic surveys, &c., from 1838 to 1847:

Year.	No. of officers employed.	No. of vessels engaged.	No. of men employed.	Expenditures.
1838	43	13	796	£68,517
1839	46	12	655	59,202
1840	45	13	656	58,862
1841	50	11	550	52,517
1842	55	15	799	91,832
1843	60	25	1,415	142,232
1844	65	23	1,470	134,126
1845	71	23	1,439	136,583
1846	77	28	1,792	178,782
1847	83	21	1,227	123,678
				1,046,331, or $5,231,665

In this statement the expenditures for the Arctic and Antarctic expeditions which were carried on during the period above given are not included; these expenses amounted to $1,000,000.

The following are the items included in the expenditures, viz: wages and provisions, expenditures of the vessels, hire of boats, instruments, extra pay of officers, office expenses, &c.*

Of the state of the charts of the coasts of Great Britain as late as 1848 the following extracts will give some idea: (From a report of Admiral Beaufort in 1848.) 1. "The greater part of the south coast of England is *very roughly laid down*, and with none of that accurate detail which is absolutely necessary." 2. "The charts of the western coast of Scotland, from the Mull of Cantire to Cape Wrath, are in a most *disgraceful state*, not only in that hydrographical minuteness requisite for the safety of navigation, but in geographical positions, many of which are several miles out, even in latitude." 3. "Two large intervals on the western coast of Ireland have *never been surveyed*, and the charts are mere eye sketches." 4. "The southeastern coast of Ireland, between Waterford and Cork, is in nearly the same condition." 5. "A full investigation of the tidal streams of the English channel is a great desideratum and ought at once to be undertaken."

From a corresponding report for the year 1844 the following extracts are taken: "At home the south and western coasts of Ireland were so little known (in 1843) that an additional survey

* British Par. Doc.

was commenced in Galway bay by means of hired boats, and the Shannon party, having finished its work, was directed to make a complete survey of Cork harbor. The Firefly was put on the soundings of the Irish channel, of which there was no accurate chart." It was estimated that the surveys of the waters of the United Kingdom might be completed in ten years, with the seven steamers and five hundred and fifty men which had been ordered for the hydrographic survey.*

The Admiralty are now carrying on surveys in the Baltic, the Mediterranean, the north coast of Africa, the south coast of Africa, the east coast of South America, the China sea, the Pacific coast of North America, and Nova Scotia.†

Of the character of the Admiralty charts, an English writer in Fraser's Magazine, speaking of the hydrographic labors of English officers, says: "Nevertheless, though these officers are now more encouraged, the crowded, insufficient, dark, and garret-like condition of our Admiralty hydrographical department is still a disgrace to the service and a cause of difficulty and delay in carrying out the daily duties of the hydrography." "The French, Russian, American, and other hydrographic departments for the public service are very superior to the English."

"It is to be regretted that the charts and sailing directions sent out to the world from time to time by the British Admiralty are neither so well suited to general use, nor so comprehensive, as some of the publications compiled from those very documents by private persons." "Arbitrary and peculiar modes of representing soundings, dangers, &c., however satisfactory to a few who read charts easily, do not suit the majority of those who use them." "Another novelty that has been adopted, in not only common sailing directions issued by authority of the Admiralty, but actually in such a standard work as Horsling's Directory, is the substitution of magnetic bearings for those true ones which remain invariable. In such cases the permanent bearings have been altered arbitrarily to those by compass, of which the correctness is doubtful, even in the year of their assumption, and which may vary in the course of years."

"At the southern extremity of America, for instance, the variation of the compass is now nearly two points easterly; in the time of Magalhaens it was only half a point easterly."

The delay in completing the hydrographic surveys of the coasts of the United Kingdom arises from not having any land survey to work upon; ten years were consumed in making a survey of lochs and bays on the north coast of Scotland which ought to have been finished in half that time.‡

The sales of Admiralty charts in the year 1855 amounted to 55,880 copies, the amount received for the charts being £2,990. The largest size charts (antiquarian) bring 3*s.*, the next size 2*s.*, and the smallest 6*d.*

A general agent is employed to sell the charts, who is allowed 40 per cent.; sub-agents are allowed 20 per cent.

The sale of Ordnance charts in 1851 amounted to £3,950, or $19,750.

Supposing the expenditures of the hydrographic department of the Admiralty to have been equal for the last ten years to the expenditures for the ten years previous to 1848, the total expenditures for hydrography in England for the last twenty years amounts to over ten millions of dollars, exclusive of the Arctic and Antartic expeditions.

It has already been shown that the expenditures on the trigonometrical surveys of the United

* Admiral Beaufort's Report in 1844.
† Jour. London Geog. Society.
‡ Admiral Beaufort's Report.

Kingdom, up to 1856, amount to nearly twelve millions of dollars, so that the total expenditures of Great Britain for surveys up to 1856, and principally within the last twenty years, amount to twenty-two millions of dollars.

Analysis of the Report of the Select Committee appointed to consider the Ordnance survey of Scotland; ordered by the House of Commons to be printed, May 6, 1856.

1. It appears that when the ordnance survey was commenced, in 1784, it was intended to produce merely a military map of the southern counties of the kingdom, but as the work advanced it came into favor as a road map, a travelling map, a county map, and general geographical map. That so it continued till 1824, when the Irish members of Parliament concluded that it would be advisable, in the adaptation of the national survey to Ireland, (the triangulation having been extended to Ireland,) to secure some further social advantages, and especially to make it subservient to the collection of taxes. A committee was appointed on the subject, which recommended a townland survey* on a scale of six inches to a mile. A six-inch scale was accordingly adopted. When a portion (the centre and southern parts) had been completed, the government extended the details of the survey from the boundaries of townlands to the subdivision of fields, and concluded to extend this detailed survey to the north; that is still in progress.

2. In 1840 all England, with the exception of six northern counties, had been surveyed on a scale of two inches, and published and engraved on a scale of one inch, and a small portion of Scotland had been previously surveyed on a similar scale.

When the survey came to the six northern counties, it was found that those thickly peopled districts could not be properly represented on a scale of one inch, and the treasury authorized the remainder of England and the whole of Scotland to be surveyed on the six-inch scale. The survey of Scotland was suspended in 1828, in order that the survey of Ireland might be proceeded with, and was resumed in 1840, the survey of Ireland having been completed.

3. In 1849 another committee was appointed, but the only recommendation they made was that the surveys of towns should precede those of the rural districts.

4. The next step was the committee on the Scotch survey in 1851. The question before the committee was, whether they would have a six-inch or a one-inch map; they pronounced in favor of the one-inch map, and orders were accordingly given that the remaining four counties of England, and the whole of Scotland, were to be done on the one-inch scale.

These instructions produced great dissatisfaction.

5. Consequently numerous petitions were received to induce the treasury to rescind the order in favor of the six-inch scale, and, in 1853, Lord Elcho drew up a memorandum on the survey which was transmitted with a treasury circular to the most distinguished scientific societies and persons in the kingdom, requesting their opinions on the relative merits of the six-inch and a larger scale, it being understood that under any circumstances the one-inch scale should be proceeded with. The replies were as follows: in favor of the six-inch scale, 32; in favor of a larger scale, 120—the latter from the most distinguished sources.

A second circular was issued to the same parties, requesting them to state what scale they would recommend.

* A townland is a subdivision of a parish, varying from 200 to 1,000 acres.

These replies were referred to a committee of three, who reported that the weight of authority was decidedly in favor of a scale of $\frac{1}{2500}$ or 25-inch scale, popularly called the "inch to the acre" scale.

Under these circumstances, the treasury determined that the surveys of Ayrshire and Dumfriesshire should be drawn on paper on the scale of $\frac{1}{2500}$, and that, until a final determination should be arrived at, the same course should be applied to the other districts.

6. Colonel James was first employed as Superintendent in 1854.

7. In 1854, the treasury recorded a minute founded on a report of Colonel James, in relation to the engraving of the ordnance survey, in which their Lordships stated that they had arrived at the following conclusions:

(1.) That it was unnecessary that the highlands should be surveyed on the $\frac{1}{2500}$ scale, and that the Superintendent should use his discretion as to what districts should be surveyed on that scale.

(2.) That the plans on the $\frac{1}{2500}$ scale should not be engraved, but that copies when wanted should be furnished by the anastatic process.*

(3.) That the highlands, and other partially cultivated districts, should be drawn on a scale of six inches, copies to be furnished by the anastatic process.

(4.) That the general map of Scotland on the one-inch scale should be proceeded with.

(5.) That plans of towns of more than 4,000 inhabitants should be drawn on a scale of $\frac{1}{500}$.

(6.) The committee find that there is a gradual progress of public opinion in favor of the 25-inch scale.

(7.) The committee find that from the evidence of Colonel Dawson attached to the Tithe and Inclosure Commission, if his suggestions made in 1837 had been complied with, there would have been a saving to the government of £3,529,830, besides a considerable further outlay in the surveys for roads, canals, water supplies, &c.

This amount was laid out on unreliable parish maps for the special purpose of commuting the tithes.

"The Chancellor of the Exchequer was urged in 1837, by Col. Dawson, to have a national survey of a scale sufficient for all purposes, and especially for the tithe commission, made. The representation was overruled, and the consequence was an outlay of two millions on unreliable parish maps."—(*Trevelyan*, 1856.†)

"There was thus an expenditure for this purpose of two millions. Colonel Dawson says the amount was £3,529,830 = $17,000,000, (seventeen millions of dollars,) which would have been enough to survey the whole of England on the largest scale."

8. The committee find that the estimate of Colonel James, of £917,000, is correct (of which £284,000 have been already expended) for the 25-inch survey; that for the 6-inch survey £817,000 would be required, and for the 1-inch survey £250,000. That the difference in cost of the 25-inch and 6-inch would be immaterial.

9. Of the £917,000, deducting £284,000 already expended, there remains a sum of £633,000; that sum would be spread over ten years, making an annual expenditure of £63,000 a year.

10. In Ireland a 1-inch map will have been obtained for £1,293,000.

* The anastatic process consists in taking a tracing from the map and turning it over on a sheet of zinc; the back of the map is then washed with dilute nitric acid, which removes the zinc, except on the lines of the drawing, where the oil protects the zinc; the plate is then ready for use.—(From the evidence of Colonel James before the committee.)

† From the evidence of Sir C. Trevelyan before the committee.

11. In England and Wales a 1-inch map has been obtained, exclusive of the six northern counties, for £989,219.

12. Whatever the first outlay may be, it may hereafter be found, as in the case of France, that it is more economical to produce first a map on a large scale, from which those on smaller scales may be reduced.

13. The delay in the ordnance survey of Scotland has been caused by the transfer of the surveying staff to Ireland.

14. The committee have come to a decision in favor of a scale of $\frac{1}{2500}$. The estimate of £917,000 includes the estimate for the publication of the 6-inch and 1-inch, reduced from the 25-inch.

15. The committee recommend the system of contouring.—(*May* 6, 1856.)

It is stated in the proceedings of the committee that the total expense of the surveys of the United Kingdom, not including the hydrography, could not be less than £4,000,000 or £5,000,000, or about twenty millions of dollars. Extract from the evidence of Colonel James before the committee, April, 1856:

"The primary triangulation of the United Kingdom, commenced in 1784, has just been completed; by primary triangulation, I mean that large triangulation which embraces the whole United Kingdom, with sides varying from sixty to one hundred and twenty miles."

The net return of sales of the ordnance maps of England and Ireland is £4,000 a year.

Note.—In Colonel James' evidence before the select committee on the ordnance survey of Scotland, he says: "Up to this year the regimental pay, every allowance to the men and officers, and every incidental expense whatever attending the survey, appeared in the votes together. This year, (1856,) without any reference to me, it is stated, after stating the sum required: '*Nota bene.*—The above is exclusive of the expense of four companies of sappers and miners employed on the survey, the same having been transferred to the land forces.'" So that the total given for the expenditures for ordnance surveys *includes* pay of sappers, officers, &c.

Extract from the evidence of Lieut. R. R. Dawson, before the select committee on the ordnance survey of Scotland, 1856: "The Austrian government has devoted for seventeen years £100,000 ($500,000) a year to carry on a survey, and contemplate a large further expenditure." Total expended by Austria in seventeen years, $8,500,000.

FRANCE.

The science of geodetic surveying originated in the labors of the French academicians to determine the correct form and dimensions of the earth, towards the close of the seventeenth century. The discussions which took place in the Academy of Sciences concerning the theory of gravitation, then just announced by Newton, led to more accurate investigations on the figure of the earth, the object being to test the correctness of this theory; and, in order to determine more accurately the length of an arc of meridian, the principle of triangulation was invented or employed for the first time. A measure of an arc near Paris, in the beginning of the eighteenth century, was the first instance in which this principle was used.

This arc was subsequently remeasured with improved instruments, while at the same time expeditions were sent to different parts of the world by Louis XV, at great expense, for the purpose of settling the question of the earth's figure.

The famous expedition to Peru, in 1735, and the trigonometrical operations on the Andes, was one of these. Another was sent to the Gulf of Bothnia, and about the year 1750 La Caille measured an arc at the Cape of Good Hope. The French arc was extended southward towards the close of the last century, and was finally completed from Dunkirk to the island of Formentera in the Mediterranean, the length of the chain of triangles being about nine hundred miles. An arc of parallel had also been measured from Bordeaux to the frontiers of Savoy. These two chains of triangles formed the basis of the map of France by Cassini, which was in use at the beginning of the present century.

A project for a new map of France was presented to the minister of war in 1816. The map of Cassini had been corrected, and the plates retouched until its existence could no longer be prolonged; and it was found also that the base upon which it was established was erroneous. It failed in all the necessary details presented by modern charts, and the configuration of the ground was incorrect. A commission, of which La Place was president, was appointed to report a plan, which plan was adopted by the King in August, 1816. This plan, according to the evidence of the director of the ordnance survey of England, before the committee of Parliament appointed to investigate the townland survey of Ireland, anticipated the expenditure of four millions of pounds, or twenty millions of dollars.

The work was commenced in 1818, by remeasuring the bases of the former survey, and extending and verifying the former triangulations. In 1827 the progress was as follows: 1. The completion of the principal chains of triangles; 2. The measurement of five bases of verification; 3. The triangulation of the first order of six quadrilaterals, by the crossing of the principal chains of triangles;* 4. Of the 249 sheets which were to compose the new atlas of France 40 were covered, each with 20 to 150 geodetic determinations of positions, producing from 7,000 to 8,000 geodetic points, by which about 30,000 tertiary positions were fixed for the topographical work, and 1,709 square leagues of the 27,000 which compose the surface of the empire were drawn.

The total area is equal to 27,000 square leagues, or 205,000 square miles. Sixteen draughtsmen, superintended by two officers, are constantly engaged in projecting the charts, on scales of $\frac{1}{20000}$ and $\frac{1}{40000}$, for the various uses of the public service. For the engraved charts the scale was established at $\frac{1}{80000}$.

Seventy-five officers, men of education, were constantly engaged in the field-work; thirty-six engravers, taken from the School of Engraving, were employed in the engraving department. In 1829 twenty-three sheets had been engraved, comprising the territory between Paris and the northern frontiers, and a chart of the triangles was nearly finished.†

The expenditures on the maps, including field and office work, pay of officers, &c., from 1818 to 1828 (ten years) amounted to 1,270,000 francs, or $254,000. It was estimated at that time that it would require thirty years to complete the survey with the force then employed.†

The progress in 1846 was as follows: Number of sheets published was 105; the number in the hands of the engraver 40; number finished on the ground 163. The primary triangulation was finished in 1844. The number of officers employed in 1846 was 78: on geodesy 14, on topography 65.‡

The number of sheets finished at the present time is 172, comprising about 163,000 square miles; the cost per acre is about $8\frac{3}{4}$ cents. The cost of each large chart was fixed at twelve francs, ($2 40,) each chart representing a surface of 130 square miles. The charts of England corresponding cost $5 20, each chart representing 108 square miles.

* The plan of the survey required the whole of France to be divided by parallel chains of triangles, so as to form quadrilaterals with sides of 200,000 metres.

† Memorial du Depôt de la Guerre, 1827. ‡ Bul. Soc. Geographie, 1846.

The surveys are executed by the Ingenieurs Geographiques and officers de l'Etat Major.

In addition to the geodetic and trigonometric operations in France, the French officers de l'Etat Major are now engaged in making a map on a large scale of the city and environs of Rome.*

An extensive triangulation of the western coast of France was commenced in 1816 under the direction of Beautemps Beaupré, and executed by the hydrographic engineers Daussy and Bégat, for the purpose of forming a basis for the survey of the coast. In 1839 a net-work of triangles had been completed from Dunkirk to St. Sebastian in Spain.†

This triangulation occupied about twenty-three years.

A triangulation of the southern coast, from Villefranc to Cape Serbêre, was finished by Bégat in 1844, for the hydrographic survey of that coast. These operations, commenced in 1816, were divided into three periods: the first, from 1816 to 1829, was occupied in the triangulation between Brest and St. Sebastian in Spain; the second, from 1829 to 1839, on the triangulation from Brest to Dunkirk; and the third, from 1839 to 1844, was occupied in the survey of the southern coast.†

The work was conducted under the direction of the "Depôt de la Marine," and was independent of the trigonometrical survey of the empire, which is carried on under the "Depôt de la Guerre;" the triangles are to be connected ultimately with the new map survey, by which they will be verified.

The French are about to redetermine the longitudes of the principal stations of the great trigonometrical survey by the method of the electric telegraph, a method which was first employed on the United States Coast Survey in 1849.

The survey of the coast, commenced in 1816 by Beautemps Beaupré, forms the basis of the accurate hydrographical charts that have been made of the seacoast of France.‡

The hydrographic surveys now embrace the whole of the seacoast of France, and their hydrographic engineers are now engaged in making charts of the coast of Italy and the coast of Algiers. A very accurate chart of the straits of Gibraltar, the first that was ever made, has just been completed. It is based on a triangulation extending some distance along the shores of Africa. The greatest depth of the straits was found to be 500 fathoms.§

The following table shows the amount of expenditure for hydrographic purposes by the Depôt de la Marine, from 1834 to 1848:

1834	706,700 francs.
1835	729,000 "
1836	733,000 "
1837	774,000 "
1838	782,000 "
1839	782,000 "
1840	725,000 "
1841	725,000 "
1942	912,000 "
1843	996,000 "
1844	970,000 "

* Bul. Soc. Geog.

† Bégat Exposé, &c., on the hydrographic operations of the coast of France.

‡ The length of the coast of France is 600 miles.

§ Journal of Geog. Soc., London.

1845	965,000 francs.
1846	966,000 "
1847	966,000 "
1848	983,000 "
Total	12,714,000 fr. = $2,544,800.*

The expenses are divided into personal and material: the personal comprise the salaries of officers of the "Depôt des Cartes et Plans;" examiners and professors of hydrography; Ecole de Maèstrance and Ecole des Aprentis, Library, Hydrographic Survey of the Coast, &c.

The material comprise the hydrographic survey of the coast, salaries of workmen, objects of art, &c., engraving and publishing, purchase of instruments, books, &c.; all the expenditures being comprised under the head of "Maritime Arts and Sciences."

The annual expenditures is now about $200,000. The annual expenditure of the Depôt de la Guerre about $80,000.

INDIA.

The most extensive geodetic operations that have been accomplished are the measurements of two arcs of meridian of colossal dimensions; one in India, about 1,500 miles in length, and the other in Europe, extending from the Black Sea to the northern boundary of Sweden, 1,800 miles in length.

These arcs form a permanent basis, respectively, for the construction of accurate maps of the countries through which they pass, and the measurement of the meridian arcs are rather incidental results of the extended chains of triangles, which had their origin in the commencement of trigonometrical surveys; the great extent of the measurements, however, furnish the most important contributions to a correct knowledge of the dimensions and geography of the globe that have ever been given.

The Indian arc was commenced by Col. Lambton, under the direction and authority of the East India Company, in 1801. The directors of the company having wisely determined to make the surveys of their extensive possessions in India dependent on trigonometrical determinations of the most accurate kind, the completion of the great chain of triangles through the heart of India, from the southern extremity to the Himalaya mountains, with the numerous subsidiary triangles along the chain, now forms a basis of operations upon which the surveyors are extending and completing the survey of India.

Col. Lambton was succeeded in 1823 by Lieut. Col. Everest, who completed the great work on the meridian arc in 1843. The total length of the arc is 21° 21′, which is equal to about fifteen hundred statute miles. The number of primary stations of the principal chain of triangles is about 200, the average length of the sides being twenty-five to thirty miles. The total number of square miles of triangulation in India is now 477,044. The cost of the geodetic work was £312,389, or one million and a half of dollars, the cost per square mile being about sixteen shillings.†

The total area of India is 1,380,000 square miles, and the population 151,000,000.

In 1822 a revenue survey was commenced in India, which consisted in the determination of the boundaries of estates with the theodolite and chain. A comparison of the revenue with

* From Reports of the French Ministers of War and Marine.
† British Par. Doc, 1851.

the trigonometrical survey shows, first, that the errors in the former amounted to from 4 to 12 feet per mile, while the cost was in favor of the trigonometrical method, including the topographical work.

In a report of the present surveyor general of India, Lieut. Col. Waugh, published in 1851, he states, "that the cost of the survey, per square mile, tends to diminish as the work advances, from the facility acquired by well trained establishments, and the very efficient mode of working exercised by the superintending officers;" "that the cost tends to diminish, if a proper system be adhered to and innovation be guarded against."*

As an illustration of the errors to which geographical maps are subject, when not based upon accurate geodetic determinations, it may be mentioned that Col. Lambton found an error of forty miles in the breadth of the peninsula of India.

The hydrographical operations of the East India Company embrace a part of the eastern coast of Africa, the Red Sea, the Persian Gulf, the Arabian Sea, the Bay of Bengal, and the China Sea. The charts published by the company up to 1849 were as follows: Coast of Africa, 4; Red Sea, 7; Southeast Coast of Arabia, 4; Persian Gulf, 21; Coast of Scinde, 26; Bay of Bengal, 27; Coast of Martaban, 13; China Seas, 38; Indian Ocean, 5.—Total 145.

These charts embrace the reconnaissance of the shores from the most eastern cape of Africa to the China Sea, the result of twenty-nine years labor. The number of officers engaged during this period was ninety, with an average salary of £150. The Bengal Presidency alone expended during this period £110,000 = $550,000, in maritime surveys. The Madras Presidency, from 1839 to 1846, seven years, expended $55,000.† The expenses of the Hydrographic Department Office in London amount to about $3,000 per annum. The price of charts sold by the East India Company varies from 1*s.* to 10*s.* 6*d.*

RUSSIA.

In 1816 Mr. W. Struve was assigned to the charge of the trigonometrical operations in the province of Livonia and Mr. De Tenner to those of Lithunia, for the purpose of making accurate surveys of those provinces. The facilities offered, however, by the region of country between the mouth of the Danube and the Baltic suggested the measurement of the great arc, the completion of which was announced by the Academy of Sciences of St. Petersburg in 1852. This great work, accomplished under the direction of the illustrious Struve, comprises a chain of triangles extending from Ismail, near the mouth of the Danube, to the northern boundary of Sweden, a distance of 1,800 miles, and embracing 25° 20′.

The northern portion of the work was executed through the co-operation of Sweden and Norway, and it is now proposed to extend it southward several degrees. The total arc is composed of sections arising from the division of the ground and the execution of the geodetic work.

1. The Norwegian arc	1° 46′,	25	primary stations.
2. The Swedish arc	3° 03′,	25	"
3. Arc of Finland	5° 46′,	73	"
4. Baltic arc	3° 35′,	33	"
5. Arc of Lithunia	4° 27′,	57	"
6. Arc of Volnia	3° 18′,	37	"
7. Arc of Bessarabia	3° 25′,	46	"

* British Par. Doc., 1851.

† The expenditures of the other Presidencies could not be ascertained.

Subtracting the identical stations, there are 275 principal stations of the triangulation. Upon this line of triangles there are ten measured bases. The latitude was determined at thirteen points of the arc.* The work occupied 36 years.

After giving a history of the various operations, Mr. Struve concludes his notice with the following remarks: "It will be seen from the preceding history that the scientific world owes the realization of this vast enterprise to the powerful protection of three monarchs, S. M. l'Empereur Alexandre, of glorious memory, S. M. l'Empereur Nicholas, and S. M. le Roi de Swede et Norway, Oscar.†

PRUSSIA.

The second great chain of triangles of Europe commences at the northeastern boundary of Prussia, and extends along the south coast of the Baltic to the island of Rugen, where it connects on the north with the triangulation of Denmark, and on the south with the triangulations of Mecklenburg and Hanover. That portion lying between Memel, near the northeastern boundary of Prussia and Fiume, was executed by the distinguished astronomer Bessel, between the years 1831 and 1836. It embraces fifteen primary stations and one base near Konigsberg. Astronomical observations for latitude were made at two stations and for azimuth at three.†

In 1836 the chain was extended by Baeyer along the shores of the Baltic and southward to Berlin, where a base of verification was measured. The number of primary stations comprised in the triangulation of Baeyer is 65, the lines varying from four to forty miles in length. The triangulations of Schumacher and Gauss extend the system over Denmark, Mecklenburg, and Hanover, whence it extends to Holland and Belgium, and through Westphalia and the Rhenish provinces to meet the surveys of France.

The geodetic operations of which this primary chain forms a basis embrace the whole of Prussia and Germany, and extend southward to connect with the surveys of Austria and Switzerland, which are again connected with the triangulations of Lombardy, Sardinia, and the Italian States, and on the west with the French survey.

The great chains of triangles which form the basis of the surveys of Europe may be described thus: 1st. The measure of the French arc of 12° 22′, (1,200 miles in length,) from Dunkirk to the island of Formentera in the Mediterranean. 2d. The arc of parallel from Bordeaux to the frontiers of Savoy, and the extension of this arc across the Alps by Austria and Sardinia combined, to meet the Austrian arc of parallel from Fiume on the Adriatic to Rivoli; thus making a complete chain from Bordeaux, on the west coast of France, to the Adriatic Sea. 3d. The great Russian arc series of triangles from the Black Sea to the Arctic ocean. 4th. The chain of Bessel, Baeyer, Schumacher, and Gauss, along the southern coast of the Baltic and the north of Germany.

Upon these great systems the whole of Europe has been covered with a net-work of triangles, forming, as far as possible, one harmonious system. The triangulation along the Baltic has been extended southward through Germany and Prussia to connect with those of Austria and Switzerland; the surveys of Switzerland and Austria are again connected with those of France, Sardinia, Lombardy, the Italian States, and Russia, and by the subdivision of the triangles and the plane-table work almost every town, hamlet, church-spire, farm, or hut, has found its proper place upon the maps which have been constructed.

* Struve.—History of the Scandinavian arc.

† Bessel and Baeyer, Gradmessung.

The following is a list of maps which have been finished or are in progress in Europe at the present time, all constructed with the most minute detail of topography by the plane-table.

*Table showing the state of topographical maps in Europe; the number of sheets required to complete the map of each country is given, and the number already finished, the number unfinished, and the scale.**

Countries.	Total number required.	Number complete.	Unfinished.	Scale.
England	108	100	8	1-63,360
France	249	172	77	1-80,000
Belgium	....	Complete.	....	1-20,000
Netherlands	62	12	50	1-50,000
Hanover	62	62	0	1-100,000
West Prussia	69	69	0	1-60,000
Hesse	36	36	0	1-50,000
Wurtemburg	56	56	0	1-50,000
Baden	56	56	0	1-50,000
Switzerland	16	10	0	1-100,000
Bavaria	99	99	0	1-50,000
Tyrol	23	23	0	1-144,000
Sardinia	41	41	0	1-86,000
Parma, and States of the Church	8	8	0	1-86,400
Illyria and Styria	37	37	0	1-144,000
Austria	37	37	0	1-144,000
Bohemia	37	23	14	1-144,000
Saxony	17	14	3	1-57,600
E. Prussia	246	190	56	1-100,000
Silesia	18	18	0	1-144,000
Gallicia	58	23	35	1-115,000
Upper Prussia	23	23	0	1-150,000

An accurate survey of Greece in 36 sheets, by Colonel Peytier, now director of the Depôt de la Guerre, has just been published.†

The trigonometrical survey of Sweden is rapidly advancing; it is to consist of 260 sheets. A set of maps has just been prepared by the hands of the Crown Prince, who takes the most active interest in the progress of the surveys. A complete trigonometrical survey of Spain has also been ordered and is in progress, only a small part of the primary triangulation, however, being completed.

Of the Atlas of India 40 sheets have been completed, and 12 are in the hands of the engravers.

With regard to the hydrographical surveys of Russia, Prussia, Sweden, and Denmark, in the Baltic, Admiral Beechey, president of the London Geographical Society, in his address before the society in 1856 says: "No fleet ever left England so well supplied with charts as the Baltic fleet in the late war. These charts were prepared by Sweden, Denmark, Norway, and Russia, under the accomplished officers Vibe, Zahrtman, Klint, and Lütke."

The hydrographic survey of the entrance to the Cattegat has been completed by Denmark, as well as a trigonometrical and hydrographic survey of Iceland.

* Petermann. † Journal London Geog. Society.

The English have two surveying vessels in the Baltic, notwithstanding the completeness of the Baltic charts.

RECAPITULATION.

ENGLAND.

The trigonometrical survey of England was begun in 1791. The total cost up to 1856 was nearly five millions of dollars. The number of persons engaged in one year, say 1843, was 1,035 officers, sappers, and civil assistants, and 560 laborers—total 1,595 persons engaged. Progress up to 1856, of the 108 sheets required for the map of England 100 are completed. Cost per square mile $150; cost per acre from 9*d*. to 12*d*. Area of England = 60,000 square miles. The survey has been in progress sixty-five years.

IRELAND.

The trigonometrical survey of Ireland commenced in 1824; finished in 1846.

Revision commenced in 1844.

The total cost of survey of Ireland, from 1824 to 1846, was five millions three hundred thousand dollars, ($5,300,000.) The number of persons engaged in one year (average of three years) was one thousand one hundred and twenty-six (1,126) officers, sappers, and civilians, and nine hundred and twenty-three (923) laborers—total 2,049 persons engaged each year, (1838, 1839, and 1840.) Time occupied 22 years; area 30,000 square miles.

SCOTLAND.

Survey commenced in 1809; total cost up to 1856, $1,418,400.

Average number of persons engaged in 1844, '45, '46, was twenty-eight officers and sappers, fifty-one civil assistants, and fifty-five laborers—total 134. Progress in 1856: survey hardly begun, except a portion of the triangulation. Time occupied forty-seven years; area of Scotland 30,000 square miles.

The total cost of the survey of England, Ireland, and Scotland, up to 1856, was twelve millions of dollars, ($12,000,000.) Area 120,000 square miles; time sixty years.

Average number of persons employed in 1840, (3,500,) three thousand five hundred.

ENGLISH HYDROGRAPHY.

Total cost for ten years ending 1847–'48 was $5,231,655; and supposing the expenditures equal to this amount for the last ten years, the expenditures for the last twenty years amount to over ten millions of dollars, ($10,000,000.)

Number of persons engaged in hydrographical surveys average yearly, from 1843 to 1847, 70 officers and 1,450 men—total 1,520. Progress: the hydrographic charts of Great Britain are still in a very unsatisfactory state; no systematic operations have been performed until within a few years, and there has been no co-operation of the land and hydrographic surveys. The total cost of trigonometrical and hydrographic surveys of Great Britain up to 1856 = $20,000,000. Length of coast of England, Ireland, and Scotland, 4,410 miles.

FRANCE.

The surveys have been in progress nearly one hundred years. The new map was commenced in 1818; it is now two-thirds finished. Expenditures on the new map up to 1828, ten years, were $254,000; at which rate the total expenditures up to the present time, 1856, amount to $1,000,000. There have been employed on the new map of France 2,500 persons, men of education, (besides the laborers,) since its commencement. The number of officers constantly employed in the field is seventy-five. Area of France 105,000 square miles; cost per acre $8\frac{3}{4}d.$ sterling. Time occupied on the new map is forty years, and it is only a little over two-thirds finished, (published.)

HYDROGRAPHY OF FRANCE.

The surveys for the charts of the coast were begun in 1816 and finished in 1844. Time 28 years, (occupied in triangulation;) length of coast 600 miles.

The total cost of the hydrographic department of France from 1834 to 1848, 14 years, was \$2,554,800; yearly expenditures from 1844 to 1848, 900,000 francs, = \$180,000. Add for ten years, 1848 to 1858, \$1,800,000, and the total cost of hydrography since 1834 is \$4,355,000. This is the expenditure of the Dépôt de la Marine. The annual expenditure for the hydrographic reconnaissance of the coast of France is 80,000 francs. Total expenditures of trigonometrical survey and hydrography of France up to 1856 amount to over five millions of dollars.

INDIA.

The surveys in India have been in operation nearly sixty years.

The survey of Russia thirty years.

The surveys of Prussia, Austria, and other States of Europe, thirty to seventy years.

The cost of the surveys of Hesse and Wurtemburg was 20 and 25 cents an acre.

The surveys of Europe are generally not so detailed and accurate as the Coast Survey of the United States.

Compared with European surveys, the progress of our Coast Survey stands in the most favorable light in the estimation of the most distinguished hydrographers of Europe. Captain W. H. Smyth, R. N., President of the Geographical Society of London, in 1850, in his address of that year says, in speaking of the United States Coast Survey: "The Coast Survey of the United States is a truly national undertaking, and has been most creditably conducted through all its various departments of science."

"I have studied the question closely, and do not hesitate to pronounce the conviction that, though the Americans were last in the field, they have *(per saltum)* leaped into the very first rank."

"Were I asked to give instances, I would say, look to their beautiful maps and charts; see their practice of establishing longitudes by electricity, and the probable extension of its wonderful chronographic application; mark their novel method of taking and recording transits by a galvanic current, and consider the excellence and refinement of their astronomical observations for geodetic purposes, as proved by their being able to detect the alteration of gravity caused by a difference in the density of the earth's crust."

In his address of 1851, Capt. Smyth says: "The very able and detailed Report of the United States Coast Survey, by Prof. Bache, has been forwarded to you by the Hon. Edward Everett and is in every respect a model for works of that kind."

In the address of Sir R. I. Murchison, before the same society, in 1852, we find the following: "The very efficient manner in which the Coast Survey of the United States is conducted under the superintendence of Professor Bache has been adverted to by my predecessor. I have now the pleasure of mentioning that the Annual Report of that distinguished physicist relative to the progress of the work during the year 1851 is, if possible, more worthy of notice than any that have preceded it, for in this document you have the ways and means by which such results are obtained along all the eastern coast through nineteen degrees of latitude, and can mark with admiration the rapidity with which the western shores of that continent have been carried on. The systematic co-operation of able surveyors of the naval and military service, combined with and subordinate to a central system of direction in the Treasury Department, and superintended by astronomers whose chief is Professor Bache, could not fail to make this one of the most *perfect exemplifications of applied science of modern times.*"

"The precision with which every observation is recorded, the light that is thrown collaterally on magnetism, meteorology, the tides and currents, as well as on hydrography and pure geography, render such reports encyclopedias of great value."

MARINE DISASTERS.[*]

The year 1854 was a year of storms, and the disasters were greater during that year than for any previous or subsequent year. The total losses from disasters to vessels, either in American waters or American vessels in foreign waters, amounted to twenty-five millions of dollars, or about fifty cents for each inhabitant of the United States.

1855.

The following is a statement of marine disasters for 1855.

Lost—Steamers	2	Missing—Ships	3
Ships	70	Barques	3
Barques	40	Brigs	3
Brigs	89	Schooners	11
Schooners	125		20
	326		
	20		
Total	346		

The value of vessels and cargoes amounted to $20,370,000.
Loss to American underwriters, $15,860,700.
Loss of lives, 430.

1856.

During six months ending July 1, 1856, the marine disasters were as follows:

Lost or disabled—Ships	112
Brigs	56
Barques	50
Schooners	87
Total	305

[*] From the files of the New York Herald and reports of the Board of Underwriters.

Total for six months 305. Losses amounted to $11,850,000.

In addition to these, 1,218 vessels reached the ports of the United States in a disabled condition, requiring repairs to the amount of $1,150,000.

Damages to cargoes not included in the above, $2,800,000.

Total losses, $15,800,000. Of these vessels the following belonged to the coasting trade between ports of the United States:

Ships	9
Barques	8
Brigs	8
Schooners	38
Steamers	3
Propeller	1
	67

The losses in coasting trade for six months were $1,295,000.

MARINE LOSSES.

1857.

Losses for six months ending July 1, 1857:

		Value.
January	125 vessels	$2,552,700
February	68 vessels	1,668,600
March	63 vessels	1,293,500
April	53 vessels	1,646,700
May	33 vessels	1,251,500
June	26 vessels	819,500
Total	368	10,232,500

IMPORTS, EXPORTS, TONNAGE, &C.

In the year 1844 the value of our foreign imports was $108,435,000. Exports $111,200,000; number of vessels entered ports of the United States was 13,843; number cleared, 13,725; the total tonnage of the vessels was 5,811,000 tons. Crews, 307,382.

In the year 1854 the value of the imports was $304,562,000; exports, $278,241,000; number of vessels entered, 19,103; cleared, 19,073. Total tonnage, 11,903,553 tons. Crews, 479,700.

Increase in number of vessels yearly, 8 per cent.

Increase in tonnage yearly, 10 per cent.

The increase of foreign, coasting, and total tonnage of the United States, was—

From 1832 to 1842, — 4 $\frac{53}{100}$ per cent.
From 1842 to 1846, — 5 $\frac{51}{100}$ per cent.
From 1846 to 1847, — 10 $\frac{8}{10}$ per cent.
From 1844 to 1854, — 10 per cent.

GREAT BRITAIN.*

The number of wrecks and casualties which occurred on the coast of Great Britain, Ireland, and Scotland were as follows:

In 1852 the number of vessels wrecked was	1,015
In 1853 the number of vessels wrecked was	832
In 1854 the number of vessels wrecked was	987
In 1855 the number of vessels wrecked was	1,141
Total in four years	3,975

The number of lives lost was—

In 1852	920
In 1853	689
In 1854	1,549
In 1855	469
Total in four years	3,627

The number of wrecks, &c., on the coast of Great Britain, &c., in 1855, was 1,141, representing 176,544 tons. Of these vessels 963 were British; 17 colonial; 116 foreign. Of these wrecks there occurred—

	563	on the east coast of Great Britain.
	251	on the west coast of Great Britain.
	117	on the south coast of Great Britain.
	127	on the Irish coast.
	10	on the Scilly islands.
	6	on the Channel islands.
	34	on the North islands.
	7	on the Lundy islands.
Total	1,141	

GULF OF MEXICO.

The number of vessels which entered and cleared at the various ports of the Gulf was—

	Vessels.	Tons.
In 1844	2,674	860,000
In 1845	2,700	865,000
In 1854	2,590	1,376,000

Increase in number of vessels, 0.

Increase of tonnage 6 per cent. per annum.

* From the English Wreck Register.

FLORIDA REEFS.

Number of vessels wrecked—

In 1844	29
In 1845	26
In 1846	58
Average	37
In 1854	33
In 1855	36
In 1856	37
Average	35

Salvage.	Repairs.	Value of vessel.	Wrecked.
$92,712	$72,352	$725,000	1844
69,591	36,115	737,000	1845
123,892	107,531	1,597,300	1846
89,474	72,724	974,000	1854
Salvage and rep ..	193,000	....	1855
172,115	248,565	....	1856

In the year 1856 four vessels were totally lost, with the following losses:

	Loss.
1 barque	$77,400
1 barque	77,000
1 ship	200,000
1 barque	100,000

APPENDIX No. 41.

Comparison of the cost and progress of the United States Coast Survey during the periods from 1832 *to* 1844, *and from* 1844 *to* 1856–'57, *by Prof. W. P. Trowbridge, Assistant in the Coast Survey.*

The total expenditure of the Coast Survey previous to 1832 was about $55,000; from 1832 to 1844 the amount expended was $766,134, and from 1844 to 1856–'57 the expenditure was $3,958,331.

The work was not effectively begun till 1832, and has therefore been in progress 25 years, including the present year. The ratio of the expenditures during the last two periods of twelve years is as 1 to 4, nearly.

From the table of "results" of the various operations of the Coast Survey we may determine the comparative amount of work done in the two periods, and thus arrive at a conclusion with regard to the economy of increasing the annual expenditure. Throwing aside the consideration that the extension of the survey to all parts of the coast was necessary, it will be seen that, viewing it as a work to be accomplished, a great saving in both time and money has been effected by the gradual increase of the expenditures, and it may be added that greater accuracy has been at the same time attained.

For the purpose of comparison the results may be divided into Field-Work and "Office-Work," and by an inspection of the table of results, we shall find that the amount of work done during the first twelve years, compared with the results of the last twelve, is as follows:

Reconnaissance as		1. to 4.1
Primary base lines		1. to 8
Secondary base lines		1. to 20.5
Length of base lines		1. to 6
Average	1. to 14.7.	
Triangulation.—Area in square miles		1. to 3.3
Extent of coast-line		1. to 8.0
Extent of shore-line		1. to 4.0
Number of points determined		1. to 5.2
Horizontal angle stations		1. to 3.7
Average	1. to 4.8.	
Astronomical observations.—Azimuth—No. of stations		1. to 6.5
Latitude—No. of stations		1. to 10.8
Longitude—No. of stations		1. to 73.0
Longitude, (permanent)		1. to 34.0
Average	1. to 39.7.	
General average of geodetic work	1. to 15.8.	

Topography.—Area in square miles	1 to 1.1	
Length of shore-line	1 to 2.6	
Original topographical maps	1 to 2.6	—Average 1 to 2.1.
Hydrography.—Number of soundings	1 to 4.4	
Tidal stations, (for sounding)	1 to 4.4	
Original hydrographic maps	1 to 3.3	—Average 1 to 4.0.

Recapitulation.

Geodetic work	1 to 15.8
Topography	1 to 2.1
Hydrography	1 to 4.0
Average for field-work	1 to 7.3

Office-work.—Reductions	1 to 21.0	
Sketches	1 to 3.0	
Manuscript maps	1 to 10.0	
Computations	1 to 8.1	—Average 1 to 19.5.

In addition to the results used in this comparison the following are found in the table, for which there were no corresponding results previous to 1844:

Tidal reduction volumes	445
Engraved plates of preliminary charts	229

Engraved plates of electrotyped	321
Published maps	63
Total number of printed sheets	224,815
Library number of volumes	2,911

And to the field-work must be added the observations on the tides, the Gulf Stream explorations, magnetic observations, and meteorological observations, all of which phenomena have been extensively observed during the last twelve years; and, in addition to the office-work above given, must be added the reduction and investigation of all these observations. The above comparison, therefore, undoubtedly falls short of rather than exceeds the truth in giving a greater amount of results in proportion to the expenditures for the last twelve years, and we may examine the results of the comparisons with regard to the economy in the increase of expenditure.

The expenditures for the last twelve years, as stated above, amounted to about four times the expenditures of the preceding twelve years; and it is shown that the field-work during the last period was about 7.3 times greater than for the preceding period, the office-work being more than ten times greater. Taking the field-work for the comparison, which is the least favorable, we have the following result:

From 1832 to 1844 expenditure 1, work done 1.
1844 to 1856–'57, " 4, " 7.3.

This comparison for an interval of twelve years, supposing the increase in expenditure and results to be gradual, gives an annual increase of expenditures of 33 per cent., and for the annual increase of work done 60 per cent. Showing a gain in economy of 27 per cent.

It is thus seen that while a gradual increase in the Coast Survey expenditures has been found necessary, in order to extend the benefits of the work to all parts of the coast at the same time, a vast gain in time and money has been effected. The national honor and reputation are involved in its speedy and accurate completion, and it is an important consideration how to accomplish it in the best and most economical manner. Beyond a certain limit it would be, no doubt, inexpedient to increase the annual expenditures for the work, but that this limit has not been exceeded the above comparisons abundantly show.

The gain in economy of 27 per cent. has not resulted entirely from the increase of expenditure; the heavy appropriations for the Western Coast account for a large portion of this increase; it is also due in a measure to the steady support of Congress and of the country, by which the Superintendent has been enabled to carry out his plans without hindrance or innovation; it is due thus to the harmony and system with which the various parts of the work are conducted so as to produce the greatest results, and to the increased facilities and qualifications of the officers of the work, acquired by many years' service.

Compared with foreign surveys we may contrast the expenditures of the United States Coast Survey with the costly works of Great Britain, France, Austria, and Russia.

The United States Coast Survey has cost up to the present time $3,700,000, including land-work and hydrography. The land-work and hydrography of Great Britain have cost over $20,000,000, and both are still incomplete. The land and hydrographic surveys of France have cost nearly $10,000,000. Austria has expended during the last seventeen years on her trigonometrical surveys $8,500,000.

These are instances which furnish a comparison most favorable to our Coast Survey as to cost; for accuracy and general usefulness the American Coast Survey charts hold, according to many distinguished foreigners, the first rank, and the scientific methods used are in many instances much in advance of those of Europe.

In no instance has any nation attempted such an extended investigation of the great natural phenomena which must directly influence navigation as the system of observations now in progress in the Coast Survey, comprehending the tides, magnetism, the Gulf Stream, currents, meteorology, and so forth, and yet these investigations, so important to science and navigation, are carried on with but little additional expense; without them the work would not be complete, with them but little is left to be desired, and when the work shall have been completed it will truly be "one of the most perfect exemplifications of applied science in modern times."

Note.—In the preceding discussion no allowance has been made for the great cost of the work on the Western Coast, compared with that on the Eastern Coast. Experience has shown that the actual cost of a given amount of work on the Western Coast has been from two to four times the cost of the same work on the Eastern. This is true, not only of the work of the Coast Survey, but also of all the public works in California and Oregon.

A just estimate requires, therefore, that this consideration should be taken into account; to do this it will only be necessary to compare the cost and progress of the Atlantic and Pacific coasts separately.

By inspecting the results of the survey it will be found that the yearly results from the Pacific coast amount to about one-fifth of the total yearly results, while the expenditures upon that coast have amounted to $884,337 in seven years; and we may establish the following comparisons:

1st. *For the Pacific coast.*—The results of the survey for the last twelve years being represented by 7.3, we have for one year $\frac{7.3}{12} = \frac{6}{10}$ nearly, and for seven years, the period during which the Western Coast Survey has been in progress, the results will be represented by 4.2. The results from the Pacific coast, being about $\frac{1}{5}$ of this, will be represented by $\frac{8}{10}$ for seven years, and we have for the Atlantic coast—expenditures previous to 1844, $766,134, work done 1. Expenditures allowed for the same work on the Pacific coast, say twice the above amount on account of the high prices, $1,532,268, work done 1. Amount actually expended in seven years, $884,337, work done $\frac{8}{10}$.

This shows a gain in economy of working, even under the high rates of labor, &c., of the Western Coast.

2d. *For the Atlantic coast.*—From the total expenditure of $2,958,331 we must subtract the expenditures for the Western Coast, viz: $884,337, which leaves $2,074,000; and from the results represented by 7.3 we must subtract the Western Coast results, which are about $\frac{2}{10}$ of 4.2 or $\frac{84}{100}$, and we have $7.3 - .84 = 6.46$ to represent the results of the Atlantic coast.

The comparison between the cost and results will be as follows:

From 1832 to 1844 expenditure 1, work 1.
1844 to 1856–'57 " 2.7, work 6.5.

Which shows an increase of 22 per cent. per annum in the expenditures and of 54 per cent. in the results, a gain of 32 per cent. in economy.

APPENDIX No. 42.

List of papers accompanying a special report made to the Treasury Department by Professor A. D. Bache, Superintendent United States Coast Survey, in December, 1857.

A. Brief statement of the progress of the Coast Survey from 1844 to 1857.

B. Detailed statements of the Coast Survey progress from 1844 to 1857, inclusive, and expenditures year by year. 1. By geographical limits. 2. By statistics. 3. Expenditures.

C. General statement of progress to 1857, inclusive.

C *bis*. Statistics of field and office work of the Coast Survey since 1843.—(Appendix No. 8, 1858.)

D. Difference of duty and leave of absence pay of officers of the navy, and pay and rations of crews of the navy on Coast Survey duty.

D *bis*. Expenditures from January 1, 1844, to June 30, 1857, from appropriations for the United States Coast Survey.

E. Review by Professor W. P. Trowbridge, assistant in the Coast Survey, relating to the origin, cost, and progress of foreign geodetic surveys, with other data for comparison with the results of the United States Coast Survey.—(Appendix No. 40, 1858.)

F. Comparison of the cost and progress of the United States Coast Survey during the periods from 1834 to 1844, and from 1844 to 1856–'57.—(Appendix No. 41, 1858.)

F *bis*. Extracts from a letter of the Secretary of the Treasury, dated February 7, 1849, submitting a report in reply to a resolution of the Senate of December 2, 1848, relating to the expenditures and results of the United States Coast Survey.

G. Estimate of time required for completing the work of the Coast Survey.

H. Number of persons employed at different periods on the Coast Survey.

I. Memorials and testimonials relative to the prosecution of the United States Coast Survey.

J. Extract from "Report of the Secretary of the Treasury on the Coast Survey, February 15, 1851."

K. Distribution made in 1857 from the Coast Survey Office of annual reports for preceding years.—(Appendix No. 22, 1857.)

L. Statement of progress made in preparing for the publication of records and results.

M. General list of developments and discoveries made by the United States Coast Survey.—(Appendix No. 8, 1857.)

N. List of Coast Survey charts, &c., published.—(See Appendix No. 19, 1858.)

N *bis*. List of original topographical sheets registered in the archives of the Coast Survey.—(See Appendix No. 23, 1857.)

N *tris*. List of original hydrographic sheets registered in the archives of the Coast Survey.—(See Appendix No. 24, 1857.)

O. Progress in weights, measures, and balances to 1847, inclusive.

P. General view of the progress made in the construction and distribution of standards, &c., to December, 1857.

Q. Expenditures incurred for the construction, &c., of standard weights, measures, and balances, from July 1, 1844, to June 30, 1857.

APPENDIX No. 43.

Tide tables for the use of navigators, prepared from the Coast Survey observations by A. D. Bache, Superintendent. (Furnished by authority of the Treasury Department to E. & G. W. Blunt, New York, and revised October, 1858.*)*

The following tables will enable navigators to ascertain the time and height of high and low water in some of the principal ports in the United States. The results are approximate, the observations being still in progress, but they may safely be used for practical purposes. The number of places of observation and the time during which many of them have been made are steadily on the increase as the Coast Survey advances.

The tides of the coast of the United States, on the Atlantic, Gulf of Mexico, and Pacific, are of three different classes. Those of the Atlantic are of the most ordinary type, ebbing and flowing twice in twenty-four hours, and having but moderate differences in height between the two successive high waters or low waters, one occurring before noon, the other after noon.

Those of the Pacific coast also ebb and flow twice during twenty-four hours, but the morning and afternoon tides differ very considerably in height; so much so that at certain periods a rock which has three feet and a half water upon it at low tide may be awash on the next succeeding low water. The intervals, too, between successive high and successive low waters may be very unequal.

The tides of ports in the Gulf of Mexico, west of Cape St. George, ebb and flow, as a rule, but once in twenty-four hours, or are single day tides. At particular parts of the month there are two small tides in the twenty-four hours. The rise and fall in all these ports is small. East of Cape St. George the rise and fall increases; there are two tides, as a rule, during the twenty-four hours, and the daily inequality referred to in the Pacific tides is large.

These peculiarities require a different way of treating the cases, and, in some of them, separate tables.

I propose to enable the navigator to find, from the Nautical Almanac, and the following tables, the time and height of high and low water, at any date within the ordinary range of difference produced by winds and other variable circumstances. I will endeavor to divest the matter of unfamiliar technical expressions, as far as practicable, though, for shortness' sake, some such terms may be employed, after defining them. The discussion of the Gulf tides has not been carried so far as to enable me to present the results in as definite a form as the others.

As is well known, the interval between the time of the moon's crossing the meridian (moon's transit) and the time of high water at a given place is nearly constant; that is, this interval varies between moderate limits, which can be assigned. The interval at full and change of the moon is known as the establishment of the port, and is ordinarily marked on the charts. As it is not generally the average of the interval during a month's tide, it is a less convenient and less accurate quantity for the use of the navigator than the average interval which is used on the Coast Survey charts, and is sometimes called the "mean" or "corrected establishment."* The following table gives the principal tidal quantities for the different ports named in the first column, where they are arranged under specific heads. The third column of the table gives the mean interval in hours and minutes between the moon's transit and the time of high water next after the transit; the fourth, the difference between the greatest and the least interval

* This term was introduced by the Rev. Dr. Whewell, who has done so much for the investigation of the laws of the tides

occurring in different parts of the month, (lunar.) A simple inspection of this column will show how important it is to determine these changes in many of the ports where they amount to more than half an hour, or to more than fifteen minutes, from the average interval. The fifth, sixth, and seventh columns refer to the height of the tide. The fifth gives, in feet, the average rise and fall or average difference between high and low water. The sixth gives the greatest difference, commonly known as the rise and fall of spring tides; and the seventh the least difference, known as the rise and fall of the neap tides.

The average duration of the flood or rising tide is given in the eighth column; of the ebb or falling tide in the ninth, and of the period during which the tide neither rises nor falls, or the "stand," in the tenth. The duration of flood is measured from the middle of the stand at low water to the middle of the stand at high water, so that the whole duration from one high water to the next, or from one low water to the next, should be given by the sum of the numbers in the eighth and ninth columns. At most of these places given in the list a mark of reference has been established for the height of the tide. I have omitted the description of these marks, (except in the following localities,) as of no particular interest in this connection.

BENCH-MARKS.

Boston.—The top of the wall or quay at the entrance to the dry dock in the Charleston navy yard is fourteen feet $\frac{76}{100}$ (or 14.76 feet) above mean low water.

New York.—The lower end of a straight line, cut in a stone wall, at the head of a wooden wharf on Governor's island, is thirteen feet $\frac{97}{100}$ (or 13.97 feet) above mean low water. The letters U. S. C. S. are cut in the same stone.

Old Point Comfort, Va.—A line cut in the wall of the light-house, one foot from the ground, on the SW. side, is eleven feet (11 feet) above mean low water.

Charleston, S. C.—The outer and lower edge of embrasure of gun No. 3, at Castle Pinckney, is ten feet $\frac{13}{100}$ (10.13 feet) above mean low water.

TABLE I.

Tide table for the coast of the United States.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION.		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2	3.	4.	5.	6.	7.	8.	9.	10.
Coast from Portland to New York.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Portland	Maine	11 25	0 44	8.9	9.9	7.6	6 14	6 12	0 20
Portsmouth	N. H.	11 23	53	8.6	9.9	7.2	6 22	6 7	21
Newburyport	Mass.	11 22	50	7.8	9.1	6.6	5 16	7 9	24
Salem	do	11 13	50	9.2	10.6	7.6	6 19	6 6	6
Boston Light	do	11 12	35	9.3	10.9	8.1	6 20	6 6	15
Boston	do	11 27	44	10.0	11.3	8.5	6 13	6 13	9
Plymouth	do	11 19	51	10.2	11.4	9.0	6 13	6 17	29
Wellfleet	do	11 5	1 13	11.2	13.2	9.2	6 6	6 17	15
Provincetown[a]	do	11 22	40	9.2	10.8	7.7	6 16	6 10	21
Monomoy	do	11 58	----------	3.8	5.3	2.6	6 25	5 59	36
Nantucket	do	12 24	37	3.1	3.6	2.6	6 23	5 44	9
Hyannis	do	12 22	----------	3.2	3.9	1.8	6 44	5 41	9
Edgartown	do	12 16	----------	2.0	2.5	1.6	6 51	5 29	24
Holmes' Hole	do	11 43	31	1.7	1.8	1.3	6 41	5 21	12
Tarpaulin Cove	do	8 4	49	2.3	2.8	1.8	6 9	6 17	34
Wood's Hole, north side	do	7 59	53	4.0	4.7	3.1	6 51	5 31	38
Wood's Hole, south side	do	8 34	45	1.6	2.0	1.2	5 17	7 10	59
Menemsha Bight	do	7 45	----------	2.7	3.9	1.8	6 14	6 14	4
Quick's Hole, north side	do	7 31	1 15	3.7	4.3	2.9	6 31	5 54	39
Quick's Hole, south side	do	7 36	1 10	3.1	3.8	2.3	6 29	5 55	40
Cuttyhunk	do	7 40	49	3.5	4.2	2.9	6 31	5 54	39
Kettle Cove	do	7 48	1 0	4.3	5.0	3.7	6 17	6 4	29
Bird Island Light	do	7 59	45	4.4	5.3	3.5	6 51	5 58	------
New Bedford entrance, (Dumpling Rock)	do	7 57	41	3.8	4.6	2.8	6 50	5 33	42
Newport	R. I.	7 45	24	3.9	4.6	3.1	6 21	6 3	23
Point Judith	do	7 32	46	3.1	3.7	2.6	6 12	6 10	1 0
Block Island	do	7 36	41	2.8	3.5	2.0	6 23	6 2	5
Montauk Point, L. I.	N. Y.	8 20	1 11	1.9	2.4	1.8	6 17	6 7	31
Sandy Hook	do	7 29	47	4.8	5.6	4.0	6 10	6 15	21
New York	do	8 13	46	4.3	5.4	3.4	6 0	6 25	28
Tarrytown	do	9 57	58	3.5	4.0	2.7	6 6	6 20	43
Long Island Sound.									
Watch Hill	R. I.	9 0	23	2.7	3.1	2.4	6 35	5 56	14
Stonington	Conn.	9 7	30	2.7	3.2	2.2	6 15	6 10	25

[a] From Major J. D. Graham's observations.

TABLE I—Continued.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION.		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Long Island Sound—Continued.		*h. m.*	*h. m.*	*Feet*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Little Gull Island	N. Y.	9 38	1 07	2.5	2.9	2.3	6 1	6 21	37
New London	Conn	9 28	52	2.6	3.1	2.1	5 56	6 26	22
New Haven	do	11 16	1 8	5.9	6.2	5.2	6 24	6 5	33
Bridgeport	do	11 11	1 3	6.5	8.0	4.7	6 1	6 7	30
Oyster Bay, L. I	N. Y.	11 7	51	7.3	9.2	5.4	6 8	6 24	25
Sands' Point, L. I	do	11 13	31	7.7	8.9	6.4	5 55	6 30	14
New Rochelle	do	11 22	3[illegible]	7.6	8.6	6.6	5 51	6 35	12
Throgs' Neck	do	11 20	39	7.3	9.2	6.1	5 50	6 33	43
Coast of New Jersey.									
Cold Spring Inlet	N. J	7 32	51	4.4	5.4	3.6	6 8	6 18	19
Cape May Landing	do	8 19	47	4.8	6.0	4.3	6 11	6 15	20
Delaware Bay and River.									
Delaware Breakwater	Del	8 0	50	3.5	4.5	3.0	6 15	6 6	26
Higbee's, Cape May	N. J.	8 33	43	4.9	6.2	3.9	6 26	6 0	19
Egg Island Light	do	9 4	51	6.0	7.0	5.1	5 52	6 27	------
Mahon's River	Del	9 52	48	5.9	6.9	5.0	6 11	6 11	------
Newcastle	do	11 53	----------	6.5	6.9	6.6	5 6	6 43	47
Philadelphia	Pa	13 18	48	6.0	6.8	5.1	4 52	7 6	------
Chesapeake Bay and rivers.									
Old Point Comfort	Va	8 17	50	2.5	3.0	2.0	6 1	6 25	14
Point Lookout	Md	12 58	45	1.4	1.9	0.7	5 59	6 19	35
Annapolis	do	16 38	40	0.9	1.0	0.8	6 11	6 15	32
Bodkin Light	do	17 42	48	1.0	1.3	0.8	5 23	7 8	------
Baltimore	do	18 33	43	1.3	1.5	0.9	5 54	6 33	------
James River, (City Point)	Va	14 11	1 0	2.8	3.0	2.5	5 14	6 58	32
Richmond	do	16 28	1 6	2.9	3.4	2.3	4 53	7 31	------
Tappahannock	do	12 32	46	1.6	1.9	1.3	5 21	7 6	------
Coast of North and South Carolina, Georgia and Florida.									
Hatteras Inlet	N. C.	7 4	57	2.0	2.2	1.8	6 7	6 7	50
Beaufort	do	7 26	50	2.8	3.3	2.2	6 11	6 10	42
Bald Head	do	7 26	34	4.3	5.0	3.4	6 18	6 17	31
Smithville	do	7 19	47	4.5	5.5	3.8	6 01	6 26	26
Wilmington	do	9 6	1 0	2.7	3.1	2.2	4 45	7 40	30
Georgetown entrance	S. C.	7 56	42	3.8	4.7	2.7	6 4	6 19	35
Bull's Island Bay	do	7 16	57	4.8	5.7	3.7	6 20	6 6	30

TABLE I—Continued.

PORT.	STATE.	INTERVAL BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION.		
		Mean interval.	Diff. between greatest and least interval.	Mean.	Spring sides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Coast of N. and S. Car., &c.—Con.		h. m.	h. m.	Feet.	Feet	Feet.	h. m.	h. m.	h. m.
Charleston, (Castle Pinckney)	S. C	7 13	36	5.3	6.3	4.6	6 36	6 9	33
St. Helena Sound	do	7 8	1 0	5.9	7.4	4.4	6 13	6 12	23
Fort Pulaski, (Savannah entrance)	Ga	7 20	41	7.0	8.0	5.9	5 49	6 35	26
Savannah, (Dry Dock Wharf)	do	8 13	51	6.5	7.6	5.5	5 4	7 22	14
Doboy Light-House	do	7 33	55	6.6	7.8	5.4	6 2	6 20	......
St. Simon's	do	7 43	46	6.8	8.2	5.4	6 10	6 16	20
Fort Clinch	Fla	7 53	1 6	5.9	6.7	5.3	6 9	6 17	......
St. John's River	do	7 28	48	4.5	5.5	3.7	5 58	6 28	16
St. Augustine	do	8 32	43	4.2	4.9	3.6	6 5	6 11	32
Cape Florida	do	8 16	51	1.5	1.7	1.2	6 0	6 25	45
Indian Key	do	8 18	49	1.8	2.4	1.2	6 36	5 48	19
Sand Key	do	8 40	....	1.2	2.0	0.6	6 31	5 55	13
Key West	do	9 22	1 12	1.3	1.6	1.0	6 59	5 25	12
Tortugas	do	9 56	1 32	1.2	1.5	0.6	6 43	5 40	......
Tampa Bay, (Egmont Key)	do	11 21	1 33	1.4	1.8	1.0	6 36	6 11	43
Cedar Keys, (Depot Key)	do	13 15	1 55	2.6	3.2	1.6	6 12	6 13	......
St. Mark's	do	13 38	2 00	2.2	2.9	1.4	6 12	6 11	......
Western Coast.									
San Diego	Cal	9 38	1 35	3.7	5.0	2.3	6 22	6 0	30
San Pedro	do	9 39	1 48	3.7	4.7	2.2	6 18	6 5	30
Cuyler's Harbor	do	9 25	1 2	3.7	5.1	2.8	6 13	6 5	......
San Luis Obispo	do	10 8	1 52	3.6	4.8	2.4	6 25	5 58	......
Monterey	do	10 22	49	3.4	4.3	2.5	6 31	6 2	35
South Farallon	do	10 37	1 16	3.6	4.4	2.8	6 18	6 9	......
San Francisco, (north beach)	do	12 6	1 4	3.6	4.3	2.8	6 39	5 51	34
Bodega	do	11 17	1 54	3.6	4.7	2.7	6 19	5 59	......
Humboldt Bay	do	12 2	1 11	4.4	5.5	3.5	6 19	6 0	......
Port Orford	O. T	11 26	1 6	5.1	6.8	3.7	6 19	6 7	39
Astoria	do	12 42	1 13	6.1	7.4	4.6	6 3	6 28	33
Nee ah Harbor	W. T	12 33	1 28	5.6	7.4	4.8	6 20	6 6	......
Port Townshend	do	3 49	1 3	4.6	5.5	4.0	6 34	5 52	......
Fort Steilacoom	do	4 46	1 6	9.2	11.1	7.2	6 3	6 25	28

NOTE.—The mean interval in column 3 has been increased by 12 hours for some of the ports in Delaware river and Chesapeake bay so as to show the succession of times from the month. Therefore, 12 hours ought to be subtracted from the establishments which are greater than 12 hours before using them.

The foregoing Table I gives the means of determining, roughly, the time and height of high water at the several ports named. The hour of transit of the moon preceding the time of high water is to be taken from the Almanac, and, the mean establishment being added, the time of high water results. Thus:

Example I.—It is required to find the time of high water at New York on November 5, 1854. The American Almanac gives *0h. 0m.* as the time of transit of the moon on that day. The mean interval for New York from Table I, column 3, is *8h. 13m.*, which, as the transit was at *0h.*, is rougbly the time of high water. The moon being full, the height is that of spring tides of column 6, viz: 5.4 feet. If the soundings on the chart are reduced to low water spring tides, 5.4 feet is to be added to them to give the depth at high water. If the soundings are reduced to mean low water the rise and fall for mean tides being 1.1 foot less than for springs, the rise or increase of depth will be half of this, or 0.6 of a foot less than 5.4 feet, which is 4.8 feet or nearly four feet ten inches.

Example II.—Required, the time of high water at Boston on January 23, 1851. From the American Almanac we find the time of the moon's southing or transit on that day *5h. 18m.* a. m., and from table I the mean interval at Boston dry-dock is *11h. 27m.*

We have, then,	*5h.*	*18m.*	time of transit.
To which add	11	27	mean interval from Table I.
	16	45	time of high water, or *4h. 45m.* p. m.

If the Greenwich Nautical Almanac is used, add *2m.* to the time of transit of Greenwich for every hour of west longitude, and its proportional part for less than an hour. It will suffice to take the half hour which may be over any number of hours, as the correction for less than this would be less than one minute, and need not be taken into account. Thus, Boston is *4h. 44m.* west of Greenwich. The correction to be applied to the time of transit of the moon is, for the four hours, eight minutes, and for the *44m.*, one minute. The time of transit on the date assumed in the preceding example is *17h. 9m.* of the 22d, or *5h. 9m.* a. m. of the 23d; to which add nine minutes, the correction just found gives *5h. 18m.*, as before ascertained from the American Almanac.

In using the United States Nautical Almanac, in the astronomical part of which the transits of the moon are given for the meridian of Washington, the corrections required may, in this first approximation for the Atlantic coast, be neglected. To find the time of the next following low water add, from Table I, the duration of ebb tide.

This gives	*4h.*	*45m.*	p. m., time of high water.
	6	13	duration of ebb tide, from Table I.
	10	58	p. m.

By subtracting the duration of flood tide we obtain the time of the preceding low water: *10h. 32m.* a. m., recollecting that *4h. 45m.* p. m. in the same as *16h. 45m.* reckoned from midnight.

The height of this tide, corresponding to the transit of *5h.*, will bring it nearly to a neap tide, and the rise and fall obtained from column 7, Table I, is 8.5 feet. The next following high water may be had by adding to the time of low water the duration of flood from Table I. Thus:

10*h*. 58*m*. p. m. time of low water January 23.
6 13 duration of flood, from Table I.

Sum 17 11 or 5*h*. 11*m*. on January 24.

On having found the time of high water, the time of the next following high water may be found by adding the duration of flood and ebb together, and their sum to the time of high water found, thus:

6*h*. 13*m*. duration of ebb tide, from Table I.
6 13 duration of flood.
12 26 duration of whole tide.
4 45 p. m., January 23, time of high water.

17 11 or 5*h*. 11*m*. a. m., 24th of January, time of the next succeeding high water.

Subtracting the same quantity will give the time of the preceding high water. Thus:

4*h*. 45*m*. p. m. or 16*h*. 45*m*. from midnight is the time of high water.
12 26 duration of flood and ebb tide.

14 19 a. m. of the 23d for the preceding high water.

The duration of the flood and the ebb being reckoned from the middle of one stand or slack water to the middle of the next, the time of beginning of stand of ebb or flood will be found by subtracting half the duration of stand or slack water given by column 10, Table I, from the time of high or low water, and the time of the end of the stand of ebb or flood by adding the same. A nearer approximation to the times and heights of high water may be obtained by the use of Tables II and III.

TABLE II.

Interval between the time of moon's transit and the time of high water for different hours of transit, and for several different ports.

Time of moon's transit.	Boston, Mass.	New York, N. Y.	Philadelphia, Pa.	Old Point Comfort, Va.	Baltimore, Md.	Smithville, N. C.	Charleston, S. C.	Ft. Pulaski, Savannah, Ga.	Key West, Fla.	San Francisco, Cal.
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	11 38	8 20	1 31	8 33	6 47	7 26	7 38	7 30	9 26	11 5
0 30	11 33	8 18	1 28	8 27	6 42	7 21	7 34	7 25	9 19	11 50
1 0	11 28	8 15	1 25	8 21	6 37	7 16	7 28	7 19	9 12	11 53
1 30	11 24	8 10	1 21	8 15	6 31	7 13	7 22	7 15	9 6	11 47
2 0	11 20	8 6	1 18	8 9	6 26	7 9	7 16	7 11	9 0	11 41
2 30	11 16	8 0	1 14	8 4	6 21	7 6	7 11	7 8	8 55	11 36
3 0	11 13	7 55	1 11	8 0	6 17	7 4	7 7	7 6	8 51	11 33
3 30	11 10	7 52	1 8	7 56	6 13	7 3	7 3	7 5	8 50	11 33
4 0	11 7	7 52	1 6	7 52	6 11	7 2	7 0	7 4	8 49	11 38
4 30	11 6	7 52	1 3	7 49	6 10	7 3	6 58	7 3	8 53	11 46
5 0	11 6	7 53	1 0	7 48	6 10	7 4	6 58	7 4	8 57	11 55
5 30	11 9	7 56	0 59	7 50	6 13	7 6	6 59	7 6	9 7	12 3
6 0	11 13	7 59	0 59	7 53	6 19	7 9	7 1	7 8	9 17	12 11
6 30	11 19	8 5	1 1	8 0	6 25	7 13	7 4	7 12	9 23	12 16
7 0	11 25	8 11	1 7	8 7	6 32	7 17	7 10	7 16	9 39	12 23
7 30	11 32	8 17	1 15	8 15	6 39	7 23	7 19	7 22	9 45	12 29
8 0	11 38	8 23	1 23	8 24	6 44	7 28	7 28	7 28	9 52	12 34
8 30	11 43	8 27	1 29	8 33	6 49	7 33	7 36	7 34	9 54	12 37
9 0	11 47	8 32	1 34	8 40	6 52	7 37	7 42	7 39	9 56	12 36
9 30	11 48	8 34	1 39	8 45	6 54	7 39	7 45	7 42	9 53	12 34
10 0	11 49	8 35	1 42	8 48	6 53	7 40	7 48	7 43	9 51	12 30
10 30	11 48	8 34	1 43	8 48	6 52	7 40	7 48	7 41	9 45	12 24
11 0	11 47	8 31	1 41	8 46	6 50	7 38	7 46	7 37	9 39	12 17
11 30	11 43	8 25	1 37	8 40	6 48	7 30	7 42	7 34	9 32	12 9

TABLE III.

Showing the rise and fall of tides, and corrections to be applied to determine the height of high water soundings on charts referring to mean low water, and to low water spring tides.

Time of moon's transit.	Boston, Mass.			New York, N. Y.			Philadelphia, Pa.			Old Point Comfort, Va.			Baltimore, Md.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	11.2	10.6	11.3	4.9	4.5	4.9	6.3	6.2	6 3	2.9	2.6	2.9	1.5	1.4	1.6	0
1	11.3	10.6	11.3	4.9	4.5	4.9	6.4	6.4	6.5	3.0	2.7	3.0	1.5	1.4	1.6	1
2	11.2	10.5	11.2	4.7	4.4	4.8	6.6	6.5	6.6	2.9	2.7	2.9	1.5	1.3	1.5	2
3	10.6	10.3	11.0	4.3	4.2	4.6	6 6	6.5	6.6	2.6	2.6	2.8	1.4	1.3	1.5	3
4	10.0	10.0	10.7	3.8	4.0	4.4	6.4	6.4	6.5	2.3	2.4	2.7	1.3	1.2	1.4	4
5	9.2	9.7	10.4	3.5	3.8	4.2	6.1	6.2	6.3	2.1	2.3	2.6	1.1	1.1	1.3	5
6	8.8	9.4	10.1	3.3	3.7	4.1	5.7	5.9	6.0	2.0	2.2	2.5	0.9	1.1	1.3	6
7	8.6	9.3	10.0	3.3	3.7	4.1	5.4	5.6	5.7	2.0	2.3	2.5	0.9	1.1	1.3	7
8	8.9	9.5	10.2	3.6	3.8	4.2	5.2	5.3	5.4	2.2	2.4	2.6	1.0	1.2	1.4	8
9	9.4	9.7	10.4	4.0	4.0	4.4	5.4	5.4	5.5	2.5	2.5	2.8	1.1	1.3	1.5	9
10	10.1	10.0	10.7	4.5	4 3	4.7	5.7	5.7	5.8	2.8	2.7	2.9	1.3	1.4	1.6	10
11	10.7	10.3	11.0	4.8	4.5	4.9	6.0	6.0	6.1	3.0	2.8	3.0	1.4	1.4	1.6	11

TABLE III—Continued.

Time of moon's transit.	Smithville, N. C.			Charleston, S. C.			Fort Pulaski, Savannah entrance.			Key West, Fla.			San Francisco, Cal.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.2	4.8	5.1	5.7	5.4	5.7	7.8	7.4	7.8	1.6	1.4	1.6	4.5	4.0	4.4	0
1	5.1	4.8	5.1	5.8	5.4	5.7	7.9	7.4	7.9	1.6	1.4	1.6	3.9	3.7	4.1	1
2	5.0	4.7	5.0	5.6	5.4	5.7	7.6	7.3	7.7	1.5	1.4	1.5	3.7	3.6	4.1	
3	4.6	4.5	4.8	5.5	5.3	5.6	7.1	7.0	7.5	1.4	1.3	1.5	3.5	3.5	4.0	
4	4 3	4.4	4.7	5.2	5.2	5.5	6.5	6.7	7.2	1.2	1.2	1.4	3.1	3.3	3.8	
5	4.0	4.3	4.6	4.9	5.1	5.4	6.1	6.5	7.0	1.0	1.1	1.3	2.8	3.1	3.6	5
6	3.8	4.2	4.5	4.8	5.0	5.3	5.8	6.4	6.8	1.0	1.1	1.3	2.7	3.1	3.6	6
7	3.8	4.1	4.4	4.7	4.9	5.2	6.0	6.5	6.9	1.0	1.1	1.3	3.0	3.3	3.7	7
8	4.0	4.2	4.5	4.8	5.0	5.3	6.4	6.7	7.1	1.1	1.2	1.3	3.4	3.5	3.9	8
9	4 3	4.3	4.6	4.9	5.1	5.4	6.9	6.9	7.4	1.3	1.3	1.4	3.8	3.6	4.1	9
10	4.7	4.6	4.9	5.2	5.3	5.6	7.4	7.0	7.6	1.4	1.3	1.5	4.0	3.8	4.2	10
11	5.0	4 7	5.0	5.5	5.4	5.8	7.8	7.2	7.8	1.6	1.4	1.6	4.2	3.8	4.3	11

In these, the variations in the interval between the moon's transit and high water are shown for some of the principal ports contained in Table I. These variations of intervals depend upon the age of the moon, and as they go through their values in half a lunar month, are known as the half monthly inequality of interval. The table extends from the 0*h.* of transit, midnight of the calendar day or full of the moon, to 11½ hours. The numbers for change of the moon correspond to those of 0*h.*, and for 13 hours (or 1*h.* p. m. of the calendar day) to 1 hour, and so on up to 23 hours. The ports for which the numbers are given are designated by the heading of the columns.

The mean interval, it will be seen, does not occur at full and change, but nearly two days afterwards, on the Atlantic coast. At Key West it occurs more nearly at full and change, and at San Francisco still more nearly.

The same remark applies to the heights; spring tides occur about two days after the full and change of the moon, and neaps two days after the first and last quarters. The use of this table of nearer approximation is quite as simple as that of Table I.

Rule to find the time of high water.—Look in the almanac for the time of moon's transit (or southing) for the date required. In the table corresponding to that time will be found the number to be added to the time of transit.

Example III.—Required the time of high water at New York, October 1, 1856. Using the United States Nautical Almanac, we find the time of moon's transit 1*h.* 24*m.* astronomical reckoning, or 1*h.* 24*m.* p. m. calendar time. From Table II, we have, under the heading of New York, for 1*h.* 30*m.* (the nearest number to the 1*h.* 24*m.* in the table) 8*h.* 10*m.*

Thus, to	1*h.*	24*m.*,	time of moon's transit,
Add	8	10	interval found from Table III,
The sum	9	34	p. m. is the time of high water on the 1st of October, 1856.

If the sum of these numbers had exceeded twelve, the tide would have belonged to October 2, and we must have gone back to the transit of the day before and computed with it to obtain the tide of October 1.

Rule to find the height of high water.—Enter Table III, column 1, with the time of moon's transit. In the column headed with the name of the place, and marked A, will be found the rise and fall corresponding to the time of transit; in column B the number to be added to soundings on the chart, where the soundings are given for mean low water; in column C, the number to be added to charts of which the soundings are given for low water spring tides.

In the foregoing example, (III,) the time of transit being between 1 and 2 hours, we find from Table III the rise and fall of tides on 1st October, 1856, between 4.9 and 4.7, the number to be added to soundings given for mean low water 4.5 feet, (column B,) and for low water spring tides (column C) 4.9 feet.

Having found the time of high water, that of low water may be obtained nearly by adding the duration of ebb from column 9, Table I. The time of the next preceding low water may be found by subtracting the duration of flood from column 8, Table I. The time of the next following high water may be found by adding the duration of both flood and ebb; and of the next preceding high water by subtracting the same duration of the whole tide.

Example IV.—To find the next high water following that of example III.

The duration of flood, column 8, Table I, for New York is 6*h.* 0*m.*; and of ebb, from column 9, is 6*h.* 25*m.*; the sum is 12*h.* 25*m.*

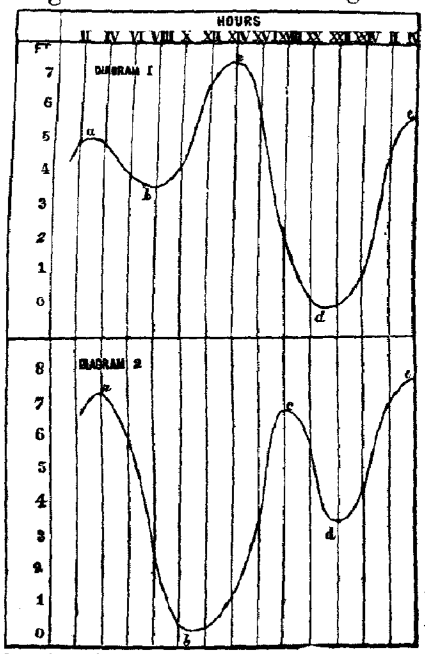
To	9*h.*	34*m.*	p. m., October 1, time of high water found,
Add	12	25	duration of flood and ebb.
Sum	21	59	or 9*h.* 59*m.* a. m. of October 2, the time of next high water.

TIDES OF THE PACIFIC COAST.

On the Pacific coast there is, as a general rule, one large and one small tide during each day, the height of the two successive high waters occuring one a. m. the other p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. The inequalities depend upon the moon's declination; they disappear near the time of the moon's declination being nothing, and are greatest about the time of its being greatest. The inequalities for low water are not the same as for high, though they disappear and have the greatest value at nearly the same times.

When the moon's declination is north, the highest of the two tides of the twenty-four hours occurs at San Francisco about eleven and a half hours after the moon's southing, (transit,) and when the declination is south, the lowest of the two high tides occurs about that interval.

The lowest of the two low waters of the day is the one which follows next the highest high water. The nature of these tides will probably appear more plainly from the annexed diagrams. In them the height of the tide is set off at the side on a scale of feet and the hours



of the day are at the top. At 12 noon, for example, the tide-gauge marked 6.7 feet. Joining all the heights observed in the twenty-four hours, we have a curve like that marked in the figure. The two high waters are *a* and *e*, and the two low waters *b* and *d*. If *a* is the high water which occurs about twelve hours after the transit of the moon, when the declination is south, the ebb *a b* is quite small, and the high water *a* is much lower than the next water, *c*. If the moon's declination is north, it is the large high water *a* of the second diagram, which occurs next after the transit and about twelve hours from it. Tables IV and V give the number to be added to the time of moon's transit to find the time of high water almost as readily as in the former case. It is one of the double entry, the time of transit being, as before, placed in the first column. The number of days from the day at which the moon has had the *greatest* declination is arranged at the *top* of the table. Entering the *first column* with the time of transit, and following the line horizontally until we come under the column containing the days from the greatest declination, we find the number to be added to the time of transit to give the time of high water. If the moon's declination is south, Table IV is to be used; if north, Table V.

Tables IV and IX, inclusive, have been recomputed, using more complete data for the inequalities above referred to.

TABLE IV.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 00	11 49	12 07	12 25	12 43	12 57	13 12	13 20	13 16	13 10	13 02	12 51	12 38	12 21	0 00
0 30	11 43	12 01	12 19	12 37	12 51	13 06	13 14	13 10	13 04	12 56	12 45	12 32	12 15	0 30
1 00	11 37	11 55	12 13	12 31	12 45	13 00	13 08	13 04	12 58	12 50	12 39	12 26	12 09	1 00
1 30	11 31	11 49	12 07	12 25	12 39	12 54	13 02	12 58	12 52	12 44	12 33	12 20	12 03	1 30
2 00	11 25	11 43	12 01	12 19	12 33	12 48	12 56	12 52	12 46	12 38	12 27	12 14	11 57	2 00
2 30	11 20	11 38	11 56	12 14	12 28	12 43	12 51	12 47	12 41	12 33	12 22	12 09	11 52	2 30
3 00	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 06	11 49	3 00
3 30	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 06	11 49	3 30
4 00	11 22	11 40	11 58	12 16	12 30	12 45	12 53	12 49	12 43	12 35	12 24	12 11	11 54	4 00
4 30	11 30	11 48	12 06	12 24	12 38	12 53	13 01	12 57	12 51	12 43	12 32	12 19	12 02	4 30
5 00	11 89	11 57	12 15	12 33	12 47	13 02	13 10	13 06	13 00	12 52	12 41	12 28	12 11	5 00
5 30	11 47	12 05	12 23	12 41	12 55	13 10	13 18	13 14	13 08	13 00	12 49	12 36	12 19	5 30
6 00	11 55	12 13	12 31	12 49	13 03	13 18	13 26	13 22	13 16	13 08	12 57	12 44	12 27	6 00
6 30	12 00	12 18	12 36	12 54	13 08	13 23	13 31	13 27	13 21	13 13	13 02	12 49	12 32	6 30
7 00	12 07	12 25	12 43	13 01	13 15	13 30	13 38	13 34	13 28	13 20	13 09	12 56	12 39	7 00
7 30	12 13	12 31	12 49	13 07	13 21	13 36	13 44	13 40	13 34	13 26	13 15	13 02	12 45	7 30
8 00	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 07	12 50	8 00
8 30	12 21	12 39	12 57	13 15	13 29	13 44	13 52	13 48	13 42	13 34	13 23	13 10	12 53	8 30
9 00	12 20	12 38	12 56	13 14	13 28	13 43	13 51	13 47	13 41	13 33	13 22	13 09	12 52	9 00
9 30	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 07	12 50	9 30
10 00	12 14	12 32	12 50	13 08	13 22	13 37	13 45	13 41	13 35	13 27	13 16	13 03	12 46	10 00
10 30	12 08	12 26	12 44	13 02	13 16	13 31	13 39	13 35	13 29	13 21	13 10	12 57	12 40	10 30
11 00	12 01	12 19	12 37	12 55	13 09	13 24	13 32	13 28	13 22	13 14	13 03	12 50	12 33	11 00
11 30	12 53	12 11	12 29	12 47	13 01	13 16	13 24	13 20	13 14	13 06	12 55	12 42	12 25	11 30

TABLE V.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 00	12 21	12 03	11 45	11 27	11 13	10 58	10 50	10 54	11 00	11 08	11 19	11 32	11 49	0 00
0 30	12 15	11 57	11 39	11 21	11 07	10 52	10 44	10 48	10 54	11 02	11 13	11 26	11 43	0 30
1 00	12 09	11 51	11 33	11 15	11 01	10 46	10 38	10 42	10 48	10 56	11 07	11 20	11 37	1 00
1 30	12 03	11 45	11 27	11 09	10 55	10 40	10 32	10 36	10 42	10 50	11 01	11 14	11 31	1 30
2 00	11 57	11 39	11 21	11 03	10 49	10 34	10 26	10 30	10 36	10 44	10 55	11 08	11 25	2 00
2 30	11 52	11 34	11 16	10 58	10 44	10 29	10 21	10 25	10 31	10 39	10 50	11 03	11 20	2 30
3 00	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 00	11 17	3 00
3 30	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 00	11 17	3 30
4 00	11 54	11 36	11 18	11 00	10 46	10 31	10 23	10 27	10 33	10 41	10 52	11 05	11 22	4 00
4 30	12 02	11 44	11 26	11 08	10 54	10 39	10 31	10 35	10 41	10 49	11 00	11 13	11 30	4 30
5 00	12 11	11 53	11 35	11 17	11 03	10 48	10 40	10 44	10 50	10 58	11 09	11 22	11 39	5 00
5 30	12 19	12 01	11 43	11 25	11 11	10 56	10 48	10 52	10 58	10 06	11 17	11 30	11 47	5 30
6 00	12 27	12 09	11 51	11 33	11 19	11 04	10 56	11 00	11 06	11 14	11 25	11 38	11 55	6 00
6 30	12 32	12 14	11 56	11 38	11 24	11 09	11 01	11 05	11 11	11 19	11 30	11 43	12 00	6 30
7 00	12 39	12 21	12 03	11 45	11 31	11 16	11 08	11 12	11 18	11 26	11 37	11 50	12 07	7 00
7 30	12 45	12 27	12 09	11 51	11 37	11 22	11 14	11 18	11 24	11 32	11 43	11 56	12 13	7 30
8 00	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 01	12 18	8 00
8 30	12 53	12 35	12 17	11 59	11 45	11 30	11 22	11 26	11 32	11 40	11 51	12 04	12 21	8 30
9 00	12 52	12 34	12 16	11 58	11 44	11 29	11 21	11 25	11 31	11 39	11 50	12 03	12 20	9 00
9 30	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 01	12 18	9 30
10 00	12 46	12 28	12 10	11 52	11 38	11 23	11 15	11 19	11 25	11 33	11 44	11 57	12 14	10 00
10 30	12 40	12 22	12 04	11 46	11 32	11 17	11 09	11 13	11 19	11 27	11 38	11 51	12 08	10 30
11 00	12 33	12 15	11 57	11 39	11 25	11 10	11 02	11 06	11 12	11 20	11 31	11 44	12 01	11 00
11 30	12 25	12 07	11 49	11 31	11 17	11 02	10 54	10 58	11 04	11 12	11 23	11 36	11 58	11 30

If we disregard the daily inequality, the column headed San Francisco, in Table II, would give us, as in the examples on the Atlantic coast, the means of determining the time of high water.

Example V.—Required the time of high water at North Beach, San Francisco, California, on the 7th February, 1853.

1st. The time of the moon's transit at Greenwich, from the Nautical Almanac, is 11*h.* 41*m.*; the longitude of San Francisco 8*h.* 10*m.*; requiring a correction of 16*m.* to the time of transit for San Francisco, which is thus found to be 11*h.* 57*m.*

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table IV we find 12*h.* (or 0*h.*) of transit, the nearest number to 11*h.* 57*m.* which the table gives; and following the line horizontally until we come to two days after the greatest declination we find 13*h.* 10*m.*

To 11*h.* 57*m.*, time of transit of moon February 7, San Francisco,
Add 13 10 from column 0*h.* transit and two days after greatest declination.
The sum 25 7 or 1*h.* 7*m.* February 8, is the time of high water corresponding to the transit which we took of February 7. If we desire the tide of February 7 we must go back to the moon's transit of the 6th. The example was purposely assumed to show this case:

11*h.* 1*m.*, time of transit February 6, 1853,
13 28 number for 11*h.* transit and one day from greatest declination.
Sum 24 29 time of high water 0*h.* 29*m.* a. m. February 7.

The height of high water.—The height of high water is obtained in a similar manner by the use of Table VI and Table VII, entering these in the same way with the time of transit and days from the greatest declination. Table VI is for south declination, and Table VII for north.

Tables showing the numbers to be added to the soundings on charts, referred to the mean lowest low waters of day, to give the depth at high water at San Francisco.

TABLE VI.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.2	4.0	3.8	3.7	3.7	3.6	3.7	3.9	4.0	4.1	4.3	4.6	4.8	0
1	3.6	3.4	3.2	3.1	3.1	3.0	3.1	3.3	3.4	3.5	3.7	4.0	4.2	1
2	3.4	3.2	3.0	2.9	2.9	2.8	2.9	3.1	3.2	3.3	3.5	3.8	4.0	2
3	3.2	3.0	2.8	2.7	2.7	2 6	2.7	2.9	3.0	2.1	3.3	2.6	3.8	3
4	2.8	2.6	2.4	2.3	2.3	2.2	2.3	2.5	2.6	2.7	2.9	3.2	3.4	4
5	2.5	2.3	2.1	2.0	2.0	1.9	2.0	2.2	2.3	2.4	2.6	2.9	3.1	5
6	2.4	2 2	2.0	1.9	1.9	1.8	1.9	2.1	2.2	2.3	2.5	2.8	3.0	6
7	2.7	2.5	2.3	2.2	2.2	2.1	2.2	2.4	2.5	2.6	2.8	3.1	3.3	7
8	3.1	2.9	2.7	2.6	2.6	2.5	2.6	2.8	2.9	3.0	3.2	3.5	3.7	8
9	3.5	3.3	3.1	3.0	3.0	2.9	3 0	3.2	3.3	3.4	3.6	3.9	4.1	9
10	3.7	3.5	3.3	3.2	3.2	3.1	3.2	3.4	3.5	3.6	3.8	4.1	4.3	10
11	3.9	3.7	3.5	3.4	3.4	3.3	3.4	3.6	3.7	3.8	4.0	4.3	4.5	11

TABLE VII.

Time of moon's transit.	NORTH DECLINATION.—DAYS OF MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						0	After—						
	6	5	4	3	2	1		1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.8	5.0	5.2	5.3	5.3	5.4	5.3	5.1	5.0	4.9	4.7	4.4	4.2	0
1	4.2	4.4	4.6	4.7	4.7	4.8	4.7	4.5	4.4	4.3	4.1	3.8	3.6	1
2	4.0	4.2	4.4	4.5	4.5	4.6	4.5	4.3	4.2	4.1	3.9	3.6	3.4	2
3	3.8	4.0	4.2	4.3	4.3	4.4	4.3	4.1	4.0	3.9	3.7	3.4	3.2	3
4	3.4	3.6	3.8	3.9	3.9	4.0	3.9	3.7	3.6	3.5	3.3	3.0	2.8	4
5	3.1	3.3	3.5	3.6	3.6	3.7	3.6	3.4	3.3	3.2	3.0	2.7	2.5	5
6	3.0	3.2	3.4	3.5	3.5	3.6	3.5	3.3	3.2	3.1	2.9	2.6	2.4	6
7	3.3	3.5	3.7	3.8	3.8	3.9	3.8	3.6	3.5	3.4	3.2	2.9	2.7	7
8	3.7	3.9	4.1	4.2	4.2	4.3	4.2	4.0	3.9	3.8	3.6	3.3	3.1	8
9	4.1	4.3	4.5	4.6	4.6	4.7	4.6	4.4	4.3	4.2	4.0	3.7	3.5	9
10	4.3	4.5	4.7	4.8	4.8	4.9	4.8	4.6	4.5	4.4	4.2	3.9	3.7	10
11	4.5	4.7	4.9	5.0	5.0	5.1	5.0	4.8	4.7	4.6	4.4	4.1	3.9	11

NOTE.—To use these tables with a chart on which the soundings are referred to mean low water, subtract 1.2 foot from the numbers in the tables.

Example VI.—In example V, to obtain the height of tide on February 7, the declination being south, we enter Table VI with 0*h.* of transit, and two days after greatest declination, and find that the tide will be 4.0 feet above the mean of the lowest low water, or that 4.0 feet are to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the soundings of the chart were given for mean low water, then 1.2 feet ought to be subtracted from the Tables VI and VII; thus, in this example, it would be 2.8 feet.

The approximate time of the successive low and high waters of the day will be found by adding the numbers in Table VIII to the time of the first high water already determined. The table gives the numbers for the different days from the greatest declination.

TABLE VIII.

Containing numbers to be added to the time of high water found from Tables IV *and* V, *to obtain the successive low and high waters.*

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	6	5 48	13 0	18 54	5 54	11 57	17 45	6	Before.
	5	5 25	12 28	18 45	6 17	12 32	17 57	5	
	4	5 3	11 50	18 29	6 39	13 10	18 13	4	
	3	4 45	11 16	18 13	6 57	13 44	18 29	3	
	2	4 30	10 46	17 58	7 12	14 14	18 44	2	
	1	4 18	10 18	17 42	7 24	14 42	19 0	1	
	0	4 12	10 0	17 30	7 30	15 00	19 12	0	
After.	1	4 24	10 10	17 28	7 18	14 50	19 14	1	After.
	2	4 34	10 20	17 28	7 8	14 40	19 14	2	
	3	4 49	10 36	17 29	6 53	14 24	19 13	3	
	4	5 6	10 58	17 34	6 36	14 2	19 8	4	
	5	5 24	11 24	17 42	6 18	13 36	19 0	5	
	6	5 51	11 53	17 45	6 52	13 8	18 59	6	

The days from the greatest declination are written in the first and last columns of the table. The second, third and fourth columns refer to south declination, and the fifth, sixth and seventh to north. The second column gives the number which is to be added, according to the declination, to the time of high water obtained by means of Tables IV and V to give the next low water, which is the small low water *b* of Diagram I. The third contains the numbers to be added to the same to give the second or large high water *c* of Diagram I. The fourth the numbers to be added to the same to give the second or large low water *d* of Diagram I. The succeeding columns give the numbers to be be used in the same way for north declination, to obtain the low water *b* (large) of Diagram II; the high water *c* (small) and the low water *d* (small) of the same diagram. The rise and fall of the same successive tides may be obtained by inspection from Table IX, in which the first column, at the side, contains the time of transit, and the successive columns the numbers corresponding to that time and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide *a b* of Diagram I, or *c d* of Diagram II, are first given; then those for small low and large high waters *b c* of Diagram I, and *d e* of Diagram II; next the large ebb tide *c d* of Diagram I, or *a b* of Diagram II; and lastly from the large low water to the small high water *d e* of Diagram I, or *b c* of Diagram II.

TABLE IX.

Showing the rise and fall of the several tides corresponding to different hours of transit, and days from greatest declination of the moon, at San Francisco.

Hour of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.												
	Days from moon's greatest declination.												
	Before—							After—					
	6	5	4	3	2	1	0	1	2	3	4	5	6
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
0	4.6	4.0	3.3	2.8	2.4	2.0	1.9	2.0	2.3	2.6	3.0	3.7	4.3
1	4.0	3.4	2.7	2.2	1.8	1.4	1.3	1.4	1.7	2.0	2.4	3.1	3.7
2	3.8	3.2	2.5	2.0	1.6	1.2	1.1	1.2	1.5	1.8	2.2	2.9	3.5
3	3.6	3.0	2.3	1.8	1.4	1.0	0.9	1.0	1.3	1.6	2.0	2.7	3.3
4	3.2	2.6	1.9	1.4	1.0	0.6	0.5	0.6	0.9	1.2	1.6	2.3	2.9
5	2.9	2.3	1.6	1.1	0.7	0.3	0.2	0.3	0.6	0.9	1.3	2.0	2.6
6	2.8	2.2	1.5	1.0	0.6	0.2	0.1	0.2	0.5	0.8	1.2	1.9	2.5
7	3.1	2.5	1.8	1.3	0 9	0.5	0.4	0.5	0.8	1.1	1.5	2.2	2.8
8	3.5	2 9	2.2	1.7	1.3	0.9	0.8	0.9	1.2	1.5	1.9	2.6	3.2
9	3.9	3.3	2.6	2.1	1.7	1.3	1.2	1.3	1.6	1.9	2.3	3.0	3.6
10	4.1	3.5	2.8	2.3	1.9	1.5	1.4	1.5	1.8	2.1	2.5	3.2	3.8
11	4.3	3.7	3.0	2.5	2.1	1.7	1.6	1.7	2.0	2.3	2.7	3.4	4.0
	From *a* to *b* .... Diagram I From *c* to *d* .... Diagram II												

FROM SMALL LOW WATER TO LARGE HIGH WATER.													Hour of moon's transit.
Days from moon's greatest declination.													
Before—							After—						
6	5	4	3	2	1	0	1	2	3	4	5	6	
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
5.2	5.0	4.7	4.4	4.0	3.8	3.5	3.2	3.3	3.4	3.4	3.5	3.7	0
4.6	4.4	4.1	3.8	3.4	3.2	2.9	2.6	2.7	2.8	2.8	2.9	3.1	1
4.4	4.2	3.9	3.6	3.2	3.0	2.7	2.4	2.5	2.6	2.6	2.7	2.9	2
4.2	4.0	3.7	3.4	3.0	2.8	2.5	2.2	2.3	2.4	2.4	2.5	2.7	3
3.8	3.6	3.3	3.0	2.6	2.4	2.1	1.8	1.9	2.0	2.0	2.1	2.3	4
3.5	3.3	3.0	2.7	2.3	2.1	1.8	1.5	1.6	1.7	1.7	1.8	2.0	5
3.4	3.2	2.9	2.6	2.2	2.0	1.7	1.4	1.5	1.6	1.6	1.7	1.9	6
3.7	3.5	3.2	2.9	2.5	2.3	2.0	1.7	1.8	1.9	1.9	2.0	2.2	7
4.1	3.9	3.6	3.3	2.9	2.7	2.4	2.1	2.2	2.3	2.3	2.4	2.6	8
4.5	4.3	4.0	3.7	3.3	3.1	2.8	2.5	2.6	2.7	2.7	2.8	3.0	9
4.7	4.5	4.2	3.9	3.5	3.3	3.0	2.7	2.8	2.9	2.9	3.0	3.2	10
4.9	4.7	4.4	4.1	3.7	3.5	3.2	2.9	3.0	3.1	3.1	3.2	3.4	11
From *b* to *c* .... Diagram I From *d* to *e* .... Diagram II													

TABLE IX—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER													FROM LARGE LOW WATER TO SMALL HIGH WATER.													Hours of moon's transit.
	Days from moon's greatest declination.													Days from moon's greatest declination.													
	Before—							After—						Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	6	5	4	3	2	1	0	1	2	3	4	5	6	
	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
0	4.4	5.0	5.7	6.2	6.6	7.0	7.1	7.0	6.7	6.4	6.0	5.3	4.7	3.8	4.0	4.3	4.6	5.0	5.2	5.5	5.8	5.7	5.6	5.6	5.5	5.3	0
1	3.8	4.4	5.1	5.6	6.0	6.4	6.5	6.4	6.1	5.8	5.4	4.7	4.1	3.2	3.4	3.7	4.0	4.4	4.6	4.9	5.2	5.1	5.0	5.0	4.9	4.7	1
2	3.6	4.2	4.9	5.4	5.8	6.2	6.3	6.2	5.9	5.6	5.2	4.5	3.9	3.0	3.2	3.5	3.8	4.2	4.4	4.7	5.0	4.9	4.8	4.8	4.7	4.5	2
3	3.4	4.0	4.7	5.2	5 6	6.0	6.1	6.0	5.7	5.4	5.0	4.3	3.7	2.8	3.0	3.3	3.6	4.0	4.2	4.5	4.8	4.7	4.6	4.6	4.5	4.3	3
4	3.0	3.6	4.3	4.8	5.2	5.6	5.7	5.6	5.3	5.0	4.6	3.9	3.3	2.4	2.6	2.9	3.2	3.6	3.8	4.1	4.4	4.3	4.2	4.2	4.1	3.9	4
5	2.7	3.3	4.0	4.5	4.9	5.3	5.4	5.3	5.0	4.7	4.3	3.6	3.0	2.1	2.3	2.6	2.9	3.3	3.5	3.8	4.1	4.0	3.9	3.9	3.8	3.6	5
6	2.6	3.2	3.9	4.4	4.8	5.2	5.3	5.2	4.9	4.6	4.2	3.5	2.9	2.0	2.2	2.5	2 8	3.2	3.4	3.7	4.0	3.9	3.8	3.8	3.7	3.5	6
7	2.9	3.5	4.2	4.7	5.1	5.5	5.6	5.5	5.2	4.9	4.5	3.8	3.2	2.3	2.5	2.8	3.1	3.5	3.7	4.0	4.3	4.2	4.1	4.1	4.0	3.8	7
8	3.3	3.9	4.6	5.1	5.5	5.9	6.0	5.9	5.6	5.3	4.9	4.2	3.6	2.7	2.9	3.2	3.5	3.9	4.1	4.4	4.7	4.6	4.5	4.5	4.4	4.2	8
9	3.7	4.3	5 0	5.5	5 9	6.3	6.4	6.3	6.0	5.7	5.3	4.6	4.0	3.1	3.3	3.6	3.9	4.3	4.5	4.8	5.1	5.0	4.9	4.9	4.8	4.6	9
10	3.9	4.5	5.2	5.7	6.1	6.5	6.6	6.5	6.2	5.9	5.5	4.8	4.2	3.3	3.5	3.8	4.1	4.5	4.7	5.0	5.3	5.2	5.1	5.1	5.0	4.8	10
11	4.1	4.7	5.4	5.9	6 3	6.7	6.8	6.7	6.4	6.1	5.7	5.0	4.4	3.5	3.7	4 0	4.3	4.7	4.9	5.2	5.5	5.4	5.3	5.3	5.2	5.0	11
	From *c* to *d*.................... ....Diagram I From *a* to *b* ....Diagram II													From *d* to *e*....................................Diagram I From *b* to *c*....................................Diagram II													

Example VII.—Thus, in Example VI, the high water of February 7 was found to be 2.8 feet above mean low water. The declination being south, Diagram I applies, and this high water is the small one. To obtain the fall of the next low water or small low water, we enter Table IX with 0*h.* of moon's transit, and two days after the greatest declination in the first part of the table, and find 2.3 feet, which will be the difference in height of this high and low water. Entering with the same transit and day in the second part, we find 3.3 feet, which is the rise of the large high above the small low water; the difference between 2.3 and 3.3, or 1.0 foot is the difference of height of the two successive high waters.

It is easy to see how, in this way, the soundings of a chart can be reduced to what they would be approximately at all the successive high and low waters. A similar set of tables is in preparation for Key West and some of the other ports on the Gulf of Mexico, where the tides are of the same character. The tidal observations now in progress on the Pacific coast will give the means of extending the tables to all the principal ports there.

TIDES OF THE GULF OF MEXICO.

On the coast of Florida, from Cape Florida, around the Peninsula, to St. Mark's, the tides are of the ordinary kind, but with a daily inequality which, small at Cape Florida, goes on increasing as we proceed westward to the Tortugas. From the Tortugas to St. Mark's the daily inequality is large and sensibly the same, giving the tides a great resemblance to those of the Pacific coast, though the rise and fall is much smaller. Between St. Mark's and St. George's island, Apalachicola entrance, the tides change to the single day class, ebbing and flowing but once in the twenty-four (lunar) hours.

At St. George's island there are two tides a day, for three or four days, about the time of the moon's declination being zero. At other times there is but one tide a day, with a long stand at high water of from 6 to 9 hours. From Cape St. Blas to and including the mouth of the Mississippi the single day tides are very regular, and the small and irregular double tides appear only for two or three days, (and frequently even not at all,) about the time of zero declination of the moon. The stand at high and low water is comparatively short, seldom exceeding an hour.

To the west of the mouth of the Mississippi the double tides reappear. At Isle Dernière they are distinct, though a little irregular, for three or four days, near the time of the moon's zero declination. At all other times the single day type prevails, the double tides modifying it, however, in the shape of a long stand of from 6 to 10 hours at high water. This stand is shortest at the time of the moon's greatest declination, sometimes being reduced to but one hour. At Calcasieu the tides are distinctly double, but with a large daily inequality. The rise and fall being small, they would often present to the ordinary observer the same appearance as at Isle Dernière. At Galveston the double tides are plainly perceptible, though small for five or six days, at the time of moon's zero declination. At other times they present the single day type, with the peculiarity that, after standing at high water for a short time, the water falls a small distance and stands again at that height for several hours, then continues to fall to low water. Sometimes it falls very slowly for nine or ten hours following high water, and then acquires a more rapid rate to low water. At Aransas Pass and Brazos Santiago the single day tides prevail. Small, irregular double tides are only perceived for two or three days at the moon's zero of declination. At all other times there is but one high water in the day, with a long stand of from 6 to 9 hours, during which there are often small, irregular fluctuations or a very slow fall. In the following table the mean rise and fall of tides at the above stations are given:

The highest high and the lowest low waters occur when the greatest declination of the moon happens at full or change; the least tide when the moon's declination is nothing at the first or last quarter. The rise and fall being so small, the times and heights are both much influenced by the winds, and are thus often rendered quite irregular.

TABLE X.—*Rise and fall at several stations on the Gulf of Mexico.*

Stations.	MEAN RISE AND FALL OF TIDES.		
	Mean.	At moon's greatest declination.	At moon's least declination.
	Feet.	*Feet.*	*Feet.*
St. George's island, Florida	1.1	1.8	0.6
Pensacola, Florida	1.0	1.5	0.4
Fort Morgan, Mobile bay, Alabama	1.0	1.5	0.4
Cat island, Mississippi	1.3	1.9	0.6
Southwest Pass, Louisiana	1.1	1.4	0.5
Isle Dernière, Louisiana	1.4	2.2	0.7
Entrance to Lake Calcasieu, Louisiana	1.9	2.4	1.7
Galveston, Texas	1.1	1.6	0.8
Aransas Pass, Texas	1.1	1.8	0.6
Brazos Santiago, Texas	0.9	1.2	0.5

TO DETERMINE THE RISE AND FALL OF THE TIDES FOR ANY GIVEN TIME FROM HIGH OR LOW WATER.

It is sometimes desirable to know how far the tide will rise in a given time from low water, or fall in a given time from high water, or to approximate to the time which has elapsed from low or high water, by knowing the rise or fall of the tide in the interval. If the proportion of the rise and fall in a given time were the same in the different ports, this would easily be shown in a single table giving the proportional rise and fall, which, by referring to Table I, showing the rise and fall of the tide at the port, would give the rise and fall in feet and decimals. The proportion, however, is not the same in different ports, nor in the same ports for tides of different heights. The following Table XI shows the relation between the heights above low water for each half hour for New York and for Old Point Comfort, and for spring and neap tides at each place. Units express the total rise of high water above low water, and the figures opposite to each half hour denote the proportional fall of the tide from high water onward to low water. For example, at New York, three hours after high water a spring tide has fallen six-tenths (sixty hundredths) of the whole fall. Suppose the whole rise and fall of that day to be 5.4 feet, (Table I;) then, three hours after high water, the tide will have fallen 3.24 feet, or three feet three inches, nearly. Conversely, if we have observed that a spring tide has fallen three feet three inches, we may know that high water has passed about three hours.

TABLE XI.

Giving the height of the tide above low water for every half hour before or after high water, the total range being taken as equal to 1.

Time before or after high water.	New York.		Old Point Comfort.	
	Spring tide.	Neap tide.	Spring tide.	Neap tide.
h. m.				
0 0	1.00	1.00	1.00	1.00
0 30	0.98	0.98	0.98	0.98
1 0	0.94	0.93	0.95	0.94
1 30	0.89	0.86	0.88	0.87
2 0	0.80	0.72	0.80	0.78
2 30	0.72	0.59	0.70	0.68
3 0	0.60	0.45	0.59	0.57
3 30	0.49	0.31	0.49	0.44
4 0	0.39	0.19	0.37	0.34
4 30	0.28	0.10	0.26	0.22
5 0	0.18	0.02	0.17	0.13
5 30	0.09	0.00	0.08	0.05
6 0	0.05	------------	0.03	0.01
6 30	0.00	------------	0.00	0.00

TIDES IN COASTING.

By observing the time of high water and low water along the coast we find the places at which they are the same. The map of co-tidal lines (Sketch No. 65, C. S. Rep., 1857,) shows that it is high water nearly at the same hour all along our coast, from Sandy Hook to Cape Cañaveral; of course, not in the bays and harbors and up the rivers, but on the outer coast.

It is high water exactly at the same hour all along the line marked XII seen on the chart, near Sandy Hook, and north and south of Hatteras, and, with small interruptions, at Cape Lookout and Cape Fear, all the way to near Cape Cañaveral. This same line extends eastward to near Block island and south of Nantucket, and then passes away from our coast.

At full and change of the moon, along this line, (approximately,) it is high water at XII o'clock, Greenwich time, the local time of high water depending upon the longitude of the place; or, to speak more correctly, in the average of a lunar month, it is high water so many hours after the time of the moon's passing the meridian of Greenwich. By these lines, called co-tidal lines, we can determine what tidal currents the navigators must expect to meet in coasting, and for this purpose we divide the ports of the coast into two sets—those south and those north of New York.

The sailing lines of coasters bound to southern ports this side of the straits of Florida are marked upon the map, and also of those bound through the sounds to eastern ports, and, outside, to Halifax and European ports.

Vessels to and from ports south of New York.

South of Sandy Hook, New Jersey, the line of XII hours is nowhere more than 18 miles from the coast; that of XI$\frac{3}{4}$ nowhere more than 35 miles; that of XI$\frac{1}{2}$ nowhere more than 48, and XI nowhere more than 110. The distance of these lines of XII to XI hours (corresponding within four minutes to VII and VI of New York time) from different parts of the coast, is shown in Table A, where the first column gives the name of the place, and the second, third, fourth, fifth, respectively, the distances of the co-tidal lines of XII, XI$\frac{3}{4}$, XI$\frac{1}{2}$, and XI hours. The distances are measured from the ports, on perpendiculars to the co-tidal lines. They may be taken as if measured on the parallel of latitude at all the points for the line of XII hours, and at all between Sandy Hook and Cape Hatteras for the lines of XI$\frac{3}{4}$ and XI$\frac{1}{2}$ hours.

A.

Names of locations.	Distance from coast, measured on perpendicular to co-tidal lines.			
	At XII hours.	At XI$\frac{3}{4}$ hours.	At XI$\frac{1}{2}$ hours.	At XI hours.
	Naut. miles.	*Naut. miles.*	*Naut. miles.*	*Naut. miles.*
Sandy Hook	12	32	53	100
Barnegat	2	29	39	78
Cape May	15	30	46	92
Cape Henlopen	18	33	47	92
Assateague	7	22	36	82
Cape Henry	12	28	43	100
Cape Hatteras		8	20	63
Ocracoke inlet		11	26	71
Cape Lookout		7	18	56
Beaufort entrance, N. C	6	15	24	63
Cape Fear		6	16	55
Cape Roman		10	21	67
Charleston light	3	15	27	70
Port Royal entrance	5	17	29	78
Tybee entrance	6	17	31	82
St. Mary's entrance	12	25	40	110
St. John's entrance	17	35	48	
Cape Cañaveral	16			
Cape Florida				

The co-tidal lines are in such directions that at 10, 20, and 30 miles from the coast, between Sandy Hook and the St. John's, there is but a variation of seven minutes, and even to Cape Cañaveral only of eight minutes. Keeping ten miles from the shore, the coaster would pass from XII hours at Sandy Hook to XI hours 45 minutes at Hatteras, and increase again irregularly to XII hours 7 minutes at the St. John's, as shown more explicitly in Table B. These three tracks of 10, 20, and 30 miles are inside of the cold wall of the Gulf Stream, and generally in the cold current, except at Cape Cañaveral.

B.

Names of stations.	Co-tidal hour at 10, 20, and 30 nautical miles from the coast, perpendicular to the coast.		
	Ten miles off.	Twenty miles off.	Thirty miles off.
	h. m.	*h. m.*	*h. m.*
Sandy Hook	12 0	11 52	11 45
Barnegat	11 52	11 44	11 35
Cape May	12 5	11 53	11 45
Cape Henlopen	12 7	11 57	11 48
Assateague	12 0	11 48	11 37
Cape Henry	12 5	11 48	11 42
Cape Hatteras	11 45	11 30	11 22
Ocracoke inlet	11 47	11 36	11 25
Cape Lookout	11 45	11 30	11 20
Beaufort entrance, N. C	11 55	11 38	11 25
Cape Fear	11 38	11 25	11 18
Cape Roman	11 45	11 33	11 24
Charleston Light	11 52	11 38	11 25
Port Royal entrance	11 57	11 45	11 32
Tybee entrance	11 55	11 43	11 30
St. Mary's entrance	12 8	11 57	11 47
St. John's entrance	12 7	11 57	11 50
Cape Cañaveral	12 8	----	----
Cape Florida	13 10	----	----

It follows, then, as a general thing, from these two tables, that the coaster in passing from Sandy Hook to the St. John's, would have the tides the same, within some fifteen minutes, as if he remained at Sandy Hook. So that leaving, for example, a high water, he would, according to the elapsed time, have the ebb and flood alternating every six hours and a quarter, nearly, as if he had remained near Sandy Hook. As the flood tide sets in generally to the northward and on shore, and the ebb to the southward and off shore, he would know by the time that elapsed from his departure and the period of the tide at which he started what tidal currents he might expect to meet as he passed along the coast. This, of course, is not peculiar to Sandy Hook as a point of departure, but would be true for any of the entrances given in the table, taking care not to mistake the time of tides within for that at the entrance.

By referring to George W. Blunt, esq., I have obtained the tracks of sailing and steam vessels passing from New York to ports to the south of it, as shown by the lines on the chart accompanying this paper.—(See Sketch No. 65, C. S. Rep., 1857.) Tracing these on the map of co-tidal lines, I have determined how the navigator would find the tides as he passes from port to port. The results are shown in the annexed table, (C,) in which the port between which and Sandy Hook the mariner passes is at the head of the table, and, at the side, the place off which the co-tidal hours will be found, as stated in the table.

C.

Off—	Co-tidal hours on sailing lines, measured on parallel of latitudes of places named in first column, between New York and—															
	Delaware bay.		Chesapeake bay.		Ocracoke inlet.		Cape Fear.		Charleston.		Savannah.		St. John's.		Cape Florida.	
	h.	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*	*h.*	*m.*
Sandy Hook	12	5	12	5	12	5	12	5	12	5	12	5	12	5	12	5
Barnegat	11	57	11	57	11	57	11	57	11	57	11	57	11	57	11	57
Cape May	12	10	11	52	11	45	11	45	11	45	11	45	11	45	11	45
Cape Henlopen			11	51	11	43	11	43	11	43	11	43	11	43	11	43
Assateague			11	55	11	33	11	33	11	33	11	33	11	33	11	33
Cape Henry			12	13	11	24	11	24	11	24	11	24	11	24	11	24
Cape Hatteras					11	48	11	48	11	48	11	48	11	48	11	48
Ocracoke inlet							11	42	11	42	11	42	11	42	11	42
Cape Lookout							11	39	11	39	11	39	11	32	11	24
Beaufort entrance							11	39	11	39	11	39	11	32	11	24
Cape Fear									11	36	11	36	11	24	11	0
Cape Roman									11	46	11	46	11	19		
Charleston light											11	52	11	18		
Port Royal entrance											12	3	11	18		
Tybee entrance													11	16		
St. Mary's entrance													11	55		
St. John's entrance													12	10		
Cape Cañaveral																
Cape Florida																

Thus, from Sandy Hook to Delaware bay, starting with XII hours 5 minutes, off Barnegat, there would be, at the same instant, XI hours 57 minutes, and off Cape May XII hours 10 minutes, so that the navigator would have the same succession of tides, whether he remained at Sandy Hook or passed onward to Delaware bay, or whether he came from Delaware bay to Sandy Hook. So from Sandy Hook to Charleston he will find, at the same instant, XII hours 5 minutes at Sandy Hook, XI hours 57 minutes off Barnegat, XI hours 45 minutes off Cape May, and so onward upon the parallels of latitude for the several points. *For all practical purposes, then, of coasting, the succession of the tides, and, of course, of the tidal currents of flood and ebb, will be the same as if the navigator remained stationary.* Leaving at low water, he will meet the flood for 6 hours 15 minutes, and then the ebb for another 6 hours 15 minutes, and so on. It is the simplest of all rules that has thus come out of this investigation. That remarkable change of temperature between the waters of the in-shore cold current, and of the warm waters of the Gulf Stream, occurring in so short a distance that Lieutenant Roche called it the "cold wall," takes place at distances off the coast of from 170 to 29 miles, (see Table D,) between Sandy

Hook and Cape Cañaveral, measured from the several points named in the table at right angles to the direction of the course, or, measured along the parallels of latitude of the points, at distance from 195 to 28 miles between Assateague and Cape Cañaveral.—(Table D.) The points where the parallels north of Assateague meet this division line have not been accurately determined.

The annexed table shows these distances, measured at right angles and on the parallel.

D.

Distance from coast to "cold wall" of Gulf Stream, off—	Measured at right angles to coast.	Measured on parallel of latitude.
	Naut. miles.	*Naut. miles.*
Sandy Hook	170	----------
Barnegat	135	----------
Cape May	137	----------
Cape Henlopen	137	----------
Assateague	95	195
Cape Henry	92	107
Cape Hatteras	30	31
Ocracoke inlet	53	52
Cape Lookout	53	65
Beaufort entrance	62	----------
Cape Fear	54	97
Cape Roman	57	103
Charleston light	61	95
Port Royal entrance	79	97
Tybee entrance	79	95
St. Mary's	90	87
St. John's	85	82
Cape Cañaveral	29	28
Cape Florida	----------	----------

The coasting line of thirty miles keeps inside of the cold wall all the way to Cañaveral, and all the routes traced on the chart from Sandy Hook to southern ports are on the inside of it. The Gulf Stream lines drawn on the chart show how the route to Bermuda and to the Bahamas cuts the alternate bands of warm and cold water of the Gulf Stream.

Vessels to and from ports east of New York.

The plate shows the sailing lines of vessels bound from New York to eastern ports and to Halifax, outside. The annexed table (E) gives the Greenwich time of high water off the several points named in the first column on the routes to and from the places named in the heading of the table. The distances are measured at right angles to the co-tidal curves.

E.

Off—	Co-tidal hours on sailing lines between New York and—						
	Newport.	New Bedford.	Nantucket.	Boston.	Portsmouth.	Portland.	Halifax.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Sandy Hook	----------	----------	----------	----------	----------	----------	12 5
Throg's Point	16 16	16 16	16 16	16 16	16 16	16 16	----------
Fisher's island	13 48	13 48	13 48	13 48	13 48	13 48	----------
Block island	12 16	12 16	12 16	12 16	12 16	12 16	11 30
Monomoy	----------	----------	----------	16 10	16 10	16 10	----------
Cape Cod	----------	----------	----------	14 35	14 35	14 35	12 15
Cape Ann	----------	----------	----------	----------	15 00	14 40	----------
Portland	----------	----------	----------	----------	----------	15 30	----------

In passing from New York to an eastern port, the first great change in the tides and tidal currents is between the East river and Long Island Sound; the difference between Governor's island and Negro Point, on Ward's island, at the eastern entrance to Hell Gate, is 2 hours 45 minutes. Between this point and Throg's Point the change is small. The mariner is now in the full tide of the Sound, and between Throg's Point and Fisher's island there is a difference of time of but 2 hours and 20 minutes, the greatest part of which is at the head of the Sound and at its entrance, that is, near Throg's Point and Fisher's island. From off New London to off Sands' Point the difference is but 1 hour and 40 minutes; so that if the mariner, instead of remaining at Throg's Point, passes onwards to Fisher's island, he would lose but half a tide in the whole passage. In other words, he would have the same succession of rise and fall, according to the time elapsed, whether stationary or passing onward within two hours and a half, or less than half a tide.

The tidal current lines show that even a less allowance is to be made for the change of current than for the change of tide, the difference in the change of current between Throg's Point and Fisher's island along the middle of the Sound being of no practical importance. Passing out of Long Island Sound, the tidal hours grow earlier, until, off Block island, that of Sandy Hook is again reached. The co-tidal line of Sandy Hook and Block island being the same, it is the struggle of the same tide through New York bay and the narrow East river and obstructed Hell Gate, and through Fisher's island and Long Island Sound and to Throg's Point. The tidal currents meet near Throg's Point.

The lower part of Narragansett bay has the co-tidal hour XII hours nearly. Buzzard's bay has nearly the same co-tidal hour, the tide-wave reaching the shore at nearly the same time all around the bay. It would be impossible to give in a small compass a minute account of the tides of Martha's Vineyard and Nantucket Sound. In general, it may be said that as far as Holmes' Hole and Wood's Hole they resemble those of Block Island Sound, and afterwards those of Monomoy, at the eastern entrance; but this generalization is unsatisfactory without more details than there is space here to give. In these Sounds takes place the remarkable change of between three and four hours, the greatest change of our coast, dislocating, as it were, the times of high water at places south and west and east and north of Nantucket. The whole of this change takes place between the eastern entrance of Nantucket Sound and the western of Martha's Vineyard, giving rise to quite a complex condition of both tides and currents, which it has occupied much time to unravel. The dominant co-tidal line of our coast, from Block island to Cape Cañaveral, is that of XII hours of Greenwich time; that of our eastern coast, from Nantucket to Passamaquoddy, is, in general, XV hours. Passing out of Nantucket Sound, coasters carry nearly the same co-tidal hour to Cape Cod, and thence vary their time about half an hour in passing to Boston, to Portsmouth, to Portland, or to Passamaquoddy. It has long been known that the tidal almanac for Boston might practically be used for eastern ports. Vessels from New York to Halifax, and New York to Europe, which keep outside, and should keep well off the Nantucket shoals, and off George's, as shown by the track on the chart, vary their co-tidal hour but little, keeping between the lines of XII and XI½ until quite well on their course and beyond Cape Sable. The same rule will apply to their case as has been given for vessels between New York and a southern port.

APPENDIX No. 44.

DIRECTORY FOR THE PACIFIC COAST OF THE UNITED STATES.

Reported to the Superintendent of the United States Coast Survey by George Davidson, Assistant.

KENSINGTON, PENN., *August* 29, 1858.

DEAR SIR: In offering for your acceptance the following Directory for the Pacific Coast of the United States, it may not be amiss to state the circumstances under which it was undertaken.

For nearly eight years the duties which you assigned to me in California, and in Oregon and Washington Territories, kept me moving continually along the seaboard in every manner of conveyance, and familiarized me with almost every mile of the coast, along which my various trips and explorations have amounted to an aggregate of between fifty and sixty thousand miles. I early felt the want of reliable information in tangible form, instead of trusting to memory, and, upon assuming the charge of the coast surveying brig R. H. Fauntleroy, I determined to embody for publication the information acquired, but several years of failing health prevented the execution of more than regular duties, until the growing desire to leave the Pacific coast forced me to occupy the remaining leisure moments in arranging the matter while yet freshly photographed upon the mind. A small portion was published in San Francisco, and, although abounding in typographical errors, the avidity with which it was sought was a strong incentive to continue the self-imposed task. The result is now placed at your disposal, and, having examined all the courses, distances and positions, I trust that no essential errors have been overlooked, but whatever have, fall upon my own shoulders.

My duties having been especially geodetic and astronomical, we naturally preceded the hydrography, and, working in comparatively unknown waters, have had constant occasion to use the lead. When seeking for an anchorage, drifting with currents, or on boat duty, I have almost invariably kept it going from my own hand. Several discoveries have rewarded our efforts.

The historical notices of previous discoveries will be found few and short, as hardly coming within the scope of the present undertaking. The descriptions may reconcile some of the discordancies of the early navigators.

Very respectfully, yours,

GEORGE DAVIDSON,
Assistant Coast Survey.

Prof. A. D. BACHE, *Superintendent U. S. Coast Survey, Washington, D. C.*

INTRODUCTORY.

Before the recent conquest of California and the discovery and development of its vast mineral wealth, comparatively little was known of the hydrography and geography of its coast, except by the few navigators trading along its seaboard, or the daring otter hunter, familiar with every cove, rock, and headland. All that had been accomplished forcibly showed that a great work had yet to be planned and executed.

It would take us far from our prescribed path to trace the extent, bearing, and importance of the successive discoveries made during a period of more than three hundred years, between 1539, when Francisco de Ulloa first determined Lower California to be a peninsula, and 1849, when the Superintendent of the United States Coast Survey first despatched a party to give definite shape to our shores. If the early adventurers and discoverers made their explorations in small crazy vessels, with wretched and untrustworthy instruments and methods, it is no less true that the first Coast Survey parties made theirs with inadequate funds, and under difficulties and privations that the well-housed Californian of to-day can never fully appreciate.

The task we have proposed to ourselves before leaving the glorious El Dorado, whose Golden Gate has admitted in ten years the commerce of every nation, and given egress to products worth five hundred millions of dollars, will be, to state all that is known at the present time of the hydrography and geography of the Pacific coast of the United States from the southern boundary in 32° 32′ to the northern boundary in 49°, embracing an ocean shore-line of over 3,120 miles, the whole divided as follows: California, including the islands of the Santa Barbara channel, 1,097 miles; Oregon Territory, 285 miles; Washington Territory, including the south side of the Strait of Juan de Fuca, Admiralty inlet, Puget's Sound, the Archipelago de Haro, &c., 1,738 miles.

The descriptions of ports, bays, anchorages, reefs, capes, islands, &c., will be given generally from personal observation made during an examination of the coast, extending through nearly eight years. Whatever has not come directly under our own criticism will be taken from the published reports and maps of the Coast Survey. The names adopted will be those most reliable. Where any changes have taken place, they will be stated if known.

With these few words of introduction, we may be pardoned in expressing a conviction that the knowledge herein conveyed will be of advantage to our extended commerce, and in assuring the navigator approaching the bold outline of our coast of the accuracy of the geographical positions. No work of the kind has heretofore been undertaken; and should it possess no other merit than serving as a nucleus for aggregating future discoveries and developments, we shall feel that our labor has not been wholly in vain.

EXPLANATORY REMARKS.

The *longitudes* of nine stations on the coast have been determined by the Coast Survey, by means of moon culminations, occultations, and solar eclipses. The observations of moon culminations at each station generally extended through three lunations. The *latitude* was determined according to the most approved methods and with the most delicate instruments. These stations and twenty-four intermediate ones have been connected by means of a large number of chronometers, (from fourteen to twenty-one,) transported by steamer, for the determination of the longitude of the intermediate ones, of which the latitude was also accurately determined in the same manner as the principal ones. Other points, including light-houses, have been determined by triangulation.

Where any position is given to the nearest minute only, it has been taken from the latest chart of the Coast Survey. The longitude is reckoned west from Greenwich.

The prediction of the tides supersedes the crude approximations of previous explorers. A table and example will be introduced to show the manner of predicting the times of high and low waters at San Francisco.

Soundings are given for low water.

Bearings are magnetic.

Distances are expressed in geographical (nautical) miles.

Magnetic declinations (variations) were determined with delicate and reliable instruments, and precautions were always taken to avoid the influence of local attraction.

Descriptions of light-houses, fog-bells, buoys, &c., are from the published notices of the Light-house Board.

COAST DIRECTORY.—MEXICO.

LOS CORONADOS.

These islands belong to Mexico; are situated between latitude 32° 24′ and 32° 27′, and longitude 117° 13′ and 117° 18′, and lie about 7 miles from the shore. They form a group of high, bold, and abrupt rocks and islets, of which the largest is 15 miles, S. 11° E. from Point Loma, between 1½ and 1¾ mile in length by one-third of a mile in width, and lying in a NW. and SE. direction. Off this lie two or three rocks to the northwestward. The smaller of the two prominent islets lies N. 58° W. from the larger, and is distant 2½ miles.

In coming from the south, this group affords a good mark for making San Diego, although before being up with them Point Loma shows distinctly.

Los Coronados were discovered and named by Juan Rodriguez Cabrillo in 1542.

PACIFIC COAST OF THE UNITED STATES.

CALIFORNIA.

This name is first found in the Journal of Bernal Diaz del Castillo, an officer who served under Cortez in the conquest of Mexico; he limits the name to a single bay.

The country was called New Albion by Sir Francis Drake in 1577. It was called Islas Carolinas, in honor of Charles II, of Spain, because the peninsula of California was supposed to be an island. The name California was afterwards applied to the peninsula, and gradually was used to designate the region from the Gulf of California to the mythical "Straits of Anian."

The monument marking the western initial point of the boundary between Mexico and the United States is on the table bluff rising from the low land south of San Diego bay. Its geographical position, as determined by the Coast Survey, is:

	°	′	″	
Latitude	32	31	58.46	north.
Longitude	117	06	11.12	west.
	h.	*m.*	*s.*	
Or, in time	7	48	24.74.	

From the boundary the coast is low and flat, running N. by W. for about 7 miles; thence curving gradually westward until it is nearly east and west at the entrance of San Diego bay.

SAN DIEGO BAY.

Next to San Francisco, no harbor on the Pacific coast of the United States approximates in excellence that of the bay of San Diego. It is easily approached, and a depth of 20 feet can be carried over the bar lying between the southern extremity of Point Loma and the tail of the Zuniga shoal. The bar is 500 yards wide between the inner and outer five fathom lines. The existence of a bar at the entrance of this port was discovered by Vancouver in 1793, and in criticizing a plan of the harbor, published by Dalrymple in 1782, he remarks: "This plan, in point of correctness, is justly entitled to much praise, but was yet capable, as far as came under my observation, of the following little improvements: the scale representing five nautical miles should only subtend three miles and a half; the shoals of Barros de Zooniga, though well placed, instead of being two distinct shoals ought to have been one entire shoal, stretching something further to the NW. and SE. than is therein represented; and the soundings between Barros de Zooniga and the land of Ponta de la Loma, (which is omitted,) are, in no part, from the south extremity of the former, directly across to the latter, more than four fathoms at high water, and form a narrow bar from the shore to the shoal, gradually deepening as well on the inside as on the outside of the bar, with a regular increase in mid channel, from five, close to the shore, to ten fathoms between the two low points that form the entrance to the port."—(Vol. II, page 473.)

As the mean rise and fall of spring tides is five feet, and of neap tides about two and a half, Vancouver's and the recent examinations of the Coast Survey confirm each other, and tend to show that the depth has remained the same for the last sixty-three years.

Point Loma is the southern part of the western boundary of the bay, and the termination of a remarkable narrow spur of coarse, crumbling sandstone rising south of Puerto Falso, or False bay, and west of the town of San Diego, to the height of 300 feet, and after stretching south for about 5½ miles, gradually increasing in height, terminates very abruptly. It is covered with coarse grass, cacti, wild sage, and low bushes.

Point Loma light-house is less than half a mile from the southern end, and situated upon the highest part of the point, which here attains an elevation of 422 feet above high water. The building consists of a stone dwelling of one and a half stories, with a low tower of brick rising from the centre sufficiently high to give full effect to the light, which is 450 feet above the sea, and was first exhibited November 15, 1855. The light is a *fixed white light* of the third order of Fresnel, exhibited from sunset to sunrise, illuminating the entire horizon, and in clear weather should be visible—

From a height of 10 feet above the sea, at a distance of 28 miles.
From a height of 20 feet above the sea, at a distance of 29 miles.
From a height of 30 feet above the sea, at a distance of 31 miles.

The geographical position of the light, as given by the Coast Survey, is:

	° ′ ″	
Latitude	32 40 13.0	north.
Longitude	117 12 22	west.
	h. m. s.	
Or, in time	7 48 49.5.	

Magnetic variation, 12° 29′ east, in April, 1851, with a yearly increase of 1′.4.

Vessels coming from the northwest make the ridge of Point Loma as a long, flat-topped island, when about 25 miles distant. This appearance is occasioned by the bay to the southwest, by the low land to the northeast, and by the Puerto Falso at the north. Approaching the south end of the point, give it a berth of about half to three-quarters of a mile in 6 and 7 fathoms, passing through the kelp. As soon as the point is passed, a long, low beach of shingle is opened, making out from the east side of the point and forming a natural breakwater, formerly called Punta de Guiranas by the Spaniards, but now designated as Ballast Point.

Round up gradually until Ballast Point is brought in range with the easternmost house of La Playa, (distant one mile from Ballast Point and on the same side of the bay,) and be careful not to open more of the village, as the shoal called Barros de Zuniga stretches south from the east side of the entrance, parallel to the ridge of Point Loma, and distant only three-quarters of a mile from it. Between Point Loma and this shoal runs the channel, which is less than half a mile wide within the three-fathom curve. With the least swell the breakers show the position and extent of the shoal, and at low tides part of it is bare.

During the summer keep as close to Point Loma as the draught of the vessel will permit, and lay on the wind up to Ballast Point, off which four fathoms can be carried within a ship's length, with 10 fathoms in mid channel. After passing Ballast Point steer for La Playa, and anchor anywhere in from 4 to 10 fathoms, with good holding ground. Inside the point, and about 250 yards N. by W. from it, is a shoal spot having only 12 feet water upon it. The shoals on the starboard hand, after entering, are plainly in sight, except at very high water. The channel, however, is buoyed, and cannot be missed. From La Playa to New San Diego, four miles distant, the channel curves to the right and contracts, but about six fathoms water may be carried that far. A mile or two beyond the town the bay becomes shoal and filled with flats.

Coming from the south, run for the extreme end of Point Loma until Ballast Point and La Playa are in range, as before, and follow the foregoing directions.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water at La Playa is IX*h.* XXXVIII*m.* The mean rise and fall of tides is 3.7 feet, of spring tides 5.0 feet, and of neap tides 2.3 feet. The mean duration of the flood is 6*h.* 25*m.*; of the ebb, 6*h.* 0*m.*; and of the stand 0*h.* 30*m.* The average difference between the corrected establishments of the a. m. and p. m. tides of the same day is 1*h.* 20*m.* for high water, and 1*h.* 6*m.* for low water. The differences, when the moon's declination is greatest, are 2*h.* 4*m.* and 1*h.* 36*m.*, respectively. The average difference in height of these two tides is 1.5 foot for the high waters and 2.1 feet for the low waters. When the moon's declination is greatest, those differences are 2.2 feet and 3.0 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 5.5 feet, and when the moon's declination is greatest 6.3 feet. The highest high tide in the twenty-four hours occurs about 9*h.* 10*m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about 3*h.* 16*m.* before when south. The lowest of the low waters occurs about 7¼ hours after the highest high tide.

When inside the harbor vessels are perfectly safe, but during very heavy southerly weather the kelp is said to be driven in in such great masses as to make vessels drag their anchors. We have never known such a case, and doubt if a vessel with good ground tackle and proper attention would suffer from this cause. Certainly there is not reach enough for the wind to raise a swell, and the holding ground is excellent.

The primary astronomical station of the Coast Survey is on the round topped hill, 100 feet high, and a quarter of a mile W.SW. of La Playa.

Its geographical position is:

	° ′ ″
Latitude	32 41 58 north.
Longitude	117 13 22 west.
	h. m. s.
Or, in time	7 48 53.5.

The eastern side of the entrance to San Diego bay is low and flat, covered with thick bushes and grass. It is called "The Island," although but a peninsula, being very low and narrow towards the head of the bay. On Ballast Point, at the base of the Point Loma ridge, are visible the ruins of the old Spanish fortifications, &c.

From Ballast Point the bay runs about north for a mile and a half; thence curves gradually to the eastward for 3 miles to New San Diego; thence to the head of the bay, southeast, 7 miles. The average width of the bay after passing La Playa is a mile and a half, but at New San Diego, after contracting to a trifle over half a mile, it again expands to about a mile and a half, with low shores and extensive marshes and flats. Many years since the San Diego river changed its course during a freshet, and emptied into San Diego bay instead of Puerto Falso, to the northwest. The result was a rapid filling in of the bay opposite the old town of San Diego. An appropriation was made by Congress to turn the channel of the river to its original bed. This was done a few years ago, but the works have not proved of sufficient strength.

The great drawback in San Diego bay is the want of fresh water, which has to be brought from the river. An effort was made in 1851 to obtain a supply at La Playa by sinking an artesian well, but after boring 635 feet the attempt was abandoned. A similar attempt, with like results, was made at New Town, both confirming the previously expressed opinion of geologists. The same amount of money would have brought it in earthen pipes from the river. During the long dry season the river loses itself in the sand, and the inhabitants are compelled to dig in its bed to obtain their supplies. Fresh provisions are readily procured here. Wood is scarce and not good.

The land in the region of San Diego bay is, with the exception of a small portion, well adapted to grazing. There are numerous tracts, of limited extent, which produce well, but they are favorably situated for irrigation, the want of rain being very much felt in every section. Back in the mountainous districts is found abundance of timber of many varieties, such as oak, pine, cedar, fir, ash, sycamore, elm, &c. Gold, silver, lead, copper, &c., are found, but the product is not remunerative. A vein of coal (lignite) has been discovered near San Diego, which is reported of excellent quality, and interested parties are erecting machinery to work the lead, but the experiment must prove a failure, because no genuine coal is to be found upon the coast, and in 1851 a report was made against this very deposit.

When fishery assumes a practical shape on this coast the harbor of San Diego will become a position of importance.

Communication with San Francisco and the northern or windward ports is maintained every week by steamer, and by regular lines of sailing vessels.

San Diego bay was discovered by Juan Rodriguez Cabrillo, a Portuguese in the service of Spain, in September, 1542; called Port San Miguel, and placed by him in latitude 34° 20′ N., showing the imperfection of the instruments and modes of observing in those days. He found great numbers of Indians here, who received him hospitably, but with cautiousness. It received its present name from Sebastian Vizcaino, who surveyed it in November, 1602.

In his time there existed a forest of tall, straight oak and other trees bordering upon the NW. side of the bay. This forest was said to be three leagues in length and half a league in breadth, whilst to the northwest of it was a good harbor, now known as Puerto Falso.

From the southern extremity of Point Loma the coast runs N. by W. for 22 miles; thence to Point Lausen, (of Vancouver, 1793,) forming the east point of San Pedro bay, NW. by W. ½ W. nearly 60 miles.

At the north end of the ridge of Point Loma is an extensive shoal bay called *Puerto Falso* or *False* bay. To the north and west of this the shore becomes compact and unbroken, except by the valleys of San Luis Rey and San Juan Capistrano. The waters off this stretch of the coast Vizcaino calls the bay of Santa Catalina.

The latest chart of San Diego bay is that accompanying the Report of the Superintendent of the Coast Survey for 1857.

SAN LUIS REY.

The Mission of San Luis Rey is the largest in Alta California, and the number of domesticated Indians formerly in its neighborhood gave it the appearance of a large and thriving settlement. It is nearly in the centre of a section of country unequalled for salubrity and productiveness, but the scarcity of rain is an insuperable drawback.

The Mission is now a military post, but very few men are stationed there.

The anchorage is very much restricted and unprotected, and now never visited. Its relative position on the coast will be seen by reference to the reconnaissance sheet of the Coast Survey published in 1852.

SAN JUAN CAPISTRANO.

Now a place of no importance, with an unprotected anchorage, rocky bottom, and bad landing.

This Mission, like all the others, is rapidly going to decay.

In latitude 33° 30½′ N., about 4 miles northwestward along the coast from the western point of Capistrano anchorage, the line of *equal magnetic declination* of 13° east cuts the shore, passing over the great transverse break of the island of Santa Catalina. This line annually moves southward a mile and a half.

The geographical position of San Juan Capistrano is marked on the sheet of general reconnaissance published by the Coast Survey Office in 1852.

SAN PEDRO BAY.

This bay is well protected in every direction, except against the winter gales from the southeast round to the southwest. During the spring, summer, and autumn, it is an excellent roadstead. From Point Fermin, which is the southeast point of high land west of the bay, the line of bluff runs exactly north and south for about two miles, being bold, and averaging 60 feet in height.

Vessels coming from the westward through the Santa Barbara channel make San Pedro hill (1,600 feet in height) forming the west side of the bay, as an island projected against the mountains to the southward and eastward. Approaching Point Vincente,* which is the southwest point of the hill, vessels can keep it close aboard, there being from 50 to 80 fathoms within a mile of the shore†; round Point Fermin within half a mile, in from 6 to 10 fathoms, and open the small island called El Moro, or, on the Coast Survey reconnaissance sketches of 1852 and chart of 1855, Dead Man's island, run for that island and when abreast of the landing, (readily recognized by the houses on the bluff,) about one mile north of Point Fermin, anchor in three fathoms, hard bottom, and half a mile off shore. Vessels must anchor a mile off to get five fathoms.

Coming from the south with northwest winds, beat in boldly until abreast of the landing; keep the lead going and anchor anywhere in its vicinity. Do not approach the low shore, to the north and east of El Moro, closer than one mile, at which limit four fathoms water will be found.

In winter, anchor further out, and more to the southward, in order to be able to slip the cable and go to sea should a heavy southeaster spring up. We have, however, seen a vessel ride out a very heavy southeast gale of three days' duration.

Wood and water are not readily obtained, and charges are high. The beef raised here is remarkably tough.

The geographical position of the Coast Survey secondary astronomical station on the bluff at the landing is:

	°	′	″	
Latitude	33	43	19.6	north.
Longitude	118	16	3.0	west.
	h.	m.	s.	
Or, in time, ...	7	53	04.2	

Magnetic variation, 13° 30′ east, in November 1853, with a yearly increase of 1′.4.

An appropriation has been made for a *light-house on Point Fermin*, and the necessary topographical survey is complete. The site recommended to the Light-house Board, by the Superintendent of the Coast Survey, is S. 15° W., and fifteen-sixteenths of a mile distant from the astronomical station.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is IX*h.* XXXIX*m.* The mean rise and fall of tides is 8.7 feet, of spring tides 4.7 feet, and of neap tides 2.2 feet. The mean duration of the flood is 6*h.* 18*m*, of the ebb 6*h.* 5*m*, and of the stand 0*h.* 30*m.* The average difference between the corrected establishments of the a. m. and p. m. tides of the same day is 1*h.* 10*m.* for high water, and 1*h.* 4*m.* for low water. The differences, when the moon's declination is greatest, are 1*h.* 55*m.* and 1*h.* 38*m.*, respectively. The average difference in height of these two tides is 1.5 feet for the high waters and 2.0 for the low waters. When the moon's declination is greatest, those differences are 2.3 feet and 3.1 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 5.6 feet, and when the moon's declination is greatest 6.6 feet. The highest high tide in the twenty-four hours occurs about 9*h.* 10*m.* after the moon's upper transit

*Named by Vancouver in 1793.

†When Vancouver was seeking for San Pedro bay he found such deep water off Point Vincente that he thought this could not be near the place; but after getting to the south and east he had a full view of the anchorage. He did not, however, enter it.

(southing) when the moon's declination is north, and about 3*h.* 16*m.* before when south. The lowest of the low waters occurs about 7 hours after the highest high tide.

The town of Los Angeles is 22 miles north by the road, from San Pedro, and is the centre of an extensive grazing, agricultural, and grape growing country.

The quantity of grapes and fruit generally shipped to San Francisco during the proper season is already enormous, supporting two large coast steamers. At all seasons one steamer finds a profitable trade. The coasting trade of this place is now greater than the aggregate trade of all the other ports south of San Francisco. Regular communication is maintained with San Francisco and other ports by steamers and lines of sailing vessels.

Over 100,000 gallons of wine, and 5,000 gallons of brandy were produced in 1854, and the culture of the grape bids fair to outstrip all others. Cotton, sugar cane, tobacco, flax and the cereals, yield productive crops; and the olive grows in abundance.

Salt works have been established within a few miles of Los Angeles, but the pond from which the salt water is obtained is comparatively small. The daily product is about five tons.

The country at the foot of the back hills is as productive as any in California, but its distance from a large market is a great hindrance to investment and improvement. The vast plains are literally covered with cattle, and many of the rancheros count their yearly increase by thousands. These cattle are driven to the mining districts and San Francisco, but during the not unusual droughts of summer great suffering is experienced, and great numbers of them perish.

The Bay of San Pedro was discovered by Cabrillo in 1542, and was called the Bay of Smoke, (Fumos.) *From Point Vincente* the coast trends N. by W. ¾ W. for about 17 miles; thence W. by S. to Point Dume,* in latitude 34° N., and longitude 118° 45′ W.; thence to Point Conversion, (of the old Spanish navigators,) 18 miles W. ½ N.

Point Duma is a peculiarly shaped point, whose extremity rises into a dome-like form, whilst the land behind it falls away, so that in making it from the west it rises into view as an island.

From Point Conversion to Buenaventura, distant 13 miles, the coast has a general trend NW. by W., and is low, flat, and sandy, being the opening of the valley of Santa Clara, through which flows the Santa Clara river. This stream is nearly dry during the summer, and terminates in lagoons and marshes, but in the rainy season a volume of water is brought down having sufficient force to break through the narrow sand beach and flow into the ocean. The configuration of the coast is shown on the Coast Survey reconnaissance sheet published in 1852.

The erection of a *sea-coast light* at or near Point Conversion has been recommended to the Light-house Board by the Superintendent of the Coast Survey.

There is excellent holding ground off Buenaventura in 10 fathoms, but the landing is not good.

The Mission of San Buenaventura is situated at the foot of the dividing ridge of the valleys of San Buenaventura and Santa Clara, about a half a mile from the shore. Its approximate geographical position is:

	°	′	
Latitude	34	15	north.
Longitude	119	15	west.

Fifteen miles westward of Buenaventura, on the coast, there is a rich deposit of sulphur, surface specimens of which have yielded 60 per cent. Around the locality are found ashes

* So called by Vancouver, in 1793.

and scoriæ. The ground is so hot as to be painful to the feet, and the gas emitted is almost suffocating.

SANTA BARBARA.

From San Buenaventura to Santa Barbara the distance is 23 miles, and the bearing nearly W. by N.

Santa Barbara is an open roadstead for all except northerly winds, which are unfrequent. On the west side of the long, low, sandy beach is a bold bluff, called Point Felipe.* The hill rising behind it is called La Vigia.

The landing is on the beach about half a mile east of Point Felipe; the shore is very low and flat as far as the town, three-quarters of a mile distant, but gradually rises to the Mission, which is a prominent object, about two miles inland.

Vessels coming from the westward first sight La Vigia, and, upon approaching the anchorage, keep outside of the line of kelp, (here nearly half a mile wide,) gradually rounding the point upon which is situated the *light-house*, two miles southwesterly of the landing, keep along the kelp until abreast of the town and anchor in 7 fathoms; or pass through the kelp and anchor on the inside in 3½ fathoms, both hard bottom. In anchoring far enough off to get 9 or 10 fathoms the bottom will be found sticky. A hydrographic sketch of the vicinity was published by the Coast Survey in 1855.

No dangers have been discovered in the kelp off this beach.

With the least swell the surf on the beach is a bad one, not falling square on, but cutting it at a sharp angle.

In winter, vessels must anchor outside of the kelp, as the gales detach and drive it shoreward in such vast quantities that, coming across a vessel's hawse, it helps to bring home her anchors.

LIGHT-HOUSE AT SANTA BARBARA.

The structure consists of a plastered dwelling of one and a half stories, with a low tower, also plastered, rising through the roof. The illuminating apparatus is of the fourth order of the system of Fresnel, and shows a *fixed red light*, illuminating the seaward half of the horizon. It is situated at an elevation of 180 feet above the sea, two miles southwestwardly from the landing on the beach, and 183 yards from the edge of the bluff. The light, as seen from the sea, will be projected against the hill rising behind it.

On account of the red color of the light, and the low order of lens, it will not be visible for the range due to the elevation, but should, in a clear atmosphere, be seen at a distance of 10 or 12 miles. It was first exhibited December 1, 1856, and shows every night from sunset to sunrise. The geographical position, as given by the Coast Survey, is:

	°	′	″	
Latitude	34	23	35	north.
Longitude	119	42	05	west.
	h.	m.	s.	
Or, in time	7	58	48.3	

Magnetic variation, 13° 30′ east in November, 1853; yearly increase, 1′.4.

The secondary astronomical station of the Coast Survey was on the slight grassy rise just in

* So called by Vancouver, in 1793; named Point Castillo on the Coast Survey charts.

from the beach, and 60 yards from the west side of the road leading to the town. Its position is:

	°	′	″	
Latitude	34	24	24.7	north.
Longitude	119	40	18.0	west.
	h.	*m.*	*s.*	
Or, in time	7	58	41.2.	

Santa Barbara is a town of considerable size, lying in the middle of an agricultural tract, running east and west, at the base of the Sierra Concepcion, but of limited breadth. The trade with San Francisco is not extensive; but this being one of the greatest stock raising districts on the coast, vast droves of cattle pass through and are sent to San Francisco and the mining districts.

The Mission is one of the largest and best establishments of the kind in California, and in the gardens attached to it the grape and olive were cultivated with success.

A large bitumen pit, about 8 miles west of Santa Barbara, empties directly into the ocean, and the bitumen, floating on the water, works *against* the summer or northwest winds even beyond Point Conception. Sulphur, in large beds and of superior quality, exists along the seaboard, and manifests itself in all the warm springs.

Wood and provisions in abundance can be easily obtained here. Water is plenty, but not so readily procured.

A very short distance back from the coast line is a range of rugged hills, over 2,000 feet high, forming part of the Sierra Concepcion, whose sides are sparsely covered with timber, and through some of whose gullies and gorges pass small streams abounding in the finest trout. From others issue warm springs having a temperature of about 117° Fahrenheit, and highly impregnated with sulphuretted hydrogen. The height of the springs by barometric measurement is about 1,200 feet.

The coast trail to San Francisco passes along the shore for a distance of 15 or 20 miles to the Gaviota pass; thence inland to the Santa Inez valley, which runs nearly parallel with the coast.

Regular communication by steamers and sailing vessels is maintained with San Francisco and other ports.

In 1542 Cabrillo visited this place and found great numbers of Indians, who came off to his ships in large canoes, and were quite hospitable. Close to the shore he found an Indian town with "*casas grandes.*" To it he gave the name Pueblo de los Canoas.

The coast line from Santa Barbara Light to Point Conception Light runs W. by S., distance 37 miles. The rugged hills westward of the Gaviota pass come close to the shore, forcing the traveller to leave the beach for their sea slope, the trail passing over steep ridges and down deep vallies.

POINT CONCEPTION is a peculiar and remarkable headland at the western entrance to the Santa Barbara channel. Once seen, it will never be forgotton. When made from the northward, or from the eastward, it rises as an island, but, upon approach, is found to be a high promontory, stretching boldly out into the ocean, and terminating abruptly. The land behind it sinks comparatively low, and at first gradually, but soon rapidly rises to the mountains, which attain an elevation of about 2,500 feet. Between three and four hundred yards south of the face of the cape is a large rock awash, upon which some of the California steamers have struck in very foggy weather. A topographical sketch of the point accompanies the Superintendent's report on the Coast Survey for 1851.

LIGHT-HOUSE AT POINT CONCEPTION.

The buildings are erected on the extremity of the cape and upon the highest part, which is 220 feet above the sea, and covered with grass and bushes like the land behind. As seen from the southward by day it will be projected against the Sierra de la Concepcion, and appear about one-third of their height from the water. The part of the range behind the light-house seems very level along its summit, and the house is seen about one-third of the length of the level range from the western part of it. The structure consists of a brick dwelling plastered, of one and a half stories, with a low tower, also of brick, and plastered, rising from the centre. The light was first exhibited February 1, 1856, and shows from sunset to sunrise. It consists of an illuminating apparatus of the first order of the system of Fresnel, and exhibits a *revolving white light, showing a flash every half minute*, throughout the entire sea horizon. It is elevated about 250 feet above the sea, and should be visible, in a favorable state of the atmosphere, from a height of—

10 feet above the sea, at a distance of 21.8 miles.

20 feet above the sea, at a distance of 23.3 miles.

30 feet above the sea, at a distance of 24.4 miles.

60 feet above the sea, at a distance of 27.1 miles.

Its geographical position, as given by the Coast Survey, is:

Latitude, 34° 26′ 47″ North.
Longitude, 120° 27′ 00″ West.
Or, in time, *8h.* 01*m.* 48.0*s.*

Magnetic variation, 13° 50′ East, in September, 1850; yearly increase, 1′.4.

The following bearings and distances are taken from the Coast Survey chart of this locality, published in 1853:

The rock off the west end of the San Miguel island, S. ½ E. distant 22 miles.

The east end of San Miguel island, SE. by S. ¼ S., distant 26 miles.

The southwest end of Santa Cruz island, SE. by E. ½ E., distant 40 miles.

Next to the islands of the Santa Barbara channel, Point Conception is the most prominent and interesting feature between San Francisco and the peninsula of Lower California. It has very justly and appropriately been termed the "Cape Horn" and the "Hatteras" of the Pacific, on account of the heavy northwesters that are here met with on coming through the channel, with a great change of climate and meteorological conditions; the transition being remarkably sudden and well defined. An investigation of the temperature of the ocean northwest and east of the cape would be highly instructive, as some characteristics would naturally be expected from the abrupt change in the direction of the mountains and coast line. We have frequently seen vessels coming from the eastward with all sail set, and light airs from the north, in a very little time reduced to short canvass upon approaching the cape, and vessels from the northwest coming before a spanking breeze lose it within a few miles after passing the cape into the channel. These last would be fortunate in reaching Santa Barbara in a day. We have known a vessel to be three days working from San Buenaventura to Santa Barbara, whilst a ten knot breeze was blowing west of Point Conception.

During some summer seasons the fog is almost interminable, but more particularly among the islands. For the space of six weeks, with clear days and nights at the Cape, the islands have been invisible; rising, however, to an elevation of 1,000 or 1,500 feet, the observer plainly sees the summits of the islands over the sea of fog which envelops them.

When the fogs prevail, they generally roll in from seaward at sunset, and clear away about ten o'clock next morning.

Point Conception was discovered by Cabrillo in 1542, and called Cape Galera. He placed it in latitude 36½ N.

The extent of shore-line from the southern boundary to Point Conception is about 250 miles.

EL COXO.

Two miles east of Point Conception is the anchorage of El Coxo, off the entrance to the valley of that name. This anchorage is a better one than that of Santa Barbara, and the kelp is not so compact. After passing Point Conception from the westward, at a distance of about three-quarters of a mile, run E. by N., and gradually round the bluff one mile distant from the cape, giving it a berth of half a mile; run on a N.NE. course for three-quarters of a mile, when the valley will open with a sand beach off it. Anchor outside or inside the kelp according to the choice of depth; five fathoms being obtained within a quarter of a mile of the shore, with hard sandy bottom. Ten fathoms water will be found half a mile from shore.

A hydrographic sketch of the anchorage was issued from the Coast Survey Office in 1852.

There is a large rancho at El Coxo, and it is one of the very best tracts for grazing. The beef has a finer flavor and more delicacy than any we have met with on the coast. At the head of the valleys and in the mountains is a species of large live oak, very brash when newly cut, but growing hard by seasoning. Willow, for fuel, and water can be obtained here, but neither in abundance. The water is disagreeable to the taste.

The primary astronomical station of the Coast Survey was on the top of the bluff, and between 250 and 300 yards W. ½ S. from the mouth of the creek. Its geographical position is as follows:

	°	′	″	
Latitude	34	26	56.3	north.
Longitude	120	25	39	west.
	h.	*m.*	*s.*	
Or, in time	8	01	42.6.	

Magnetic variation, 13° 50′ east, in September, 1850; yearly increase 1′·4.

In passing this valley in 1793 Vancouver saw an Indian village, the inhabitants of which made signs for him to land.

ISLANDS OF THE SANTA BARBARA CHANNEL.

The name El Canal de Santa Barbara was given by Vizcaino, in December, 1602, to the narrowest part of the channel lying east and west, and about 24 leagues in length.

Until the Coast Survey first examined in detail the islands lying off the main, between San Diego and Point Conception, nothing accurate was known of their number, peculiarities, extent, or position. Upon all maps, of as recent date as 1850, an island called San Juan was laid down; and upon a map of the republic of Mexico, compiled in the United States, and dated 1847, we find no less than twelve large islands, the positions and extent of which are most grotesquely erroneous. The island of San Miguel, the most western of the Santa Barbara group, is placed 70 miles SE. of Point Conception, instead of 23 miles SE. by S. ½ S. The same general remarks will apply to the coast line as thereon represented.

Three large rivers are made to flow into the sea between Santa Barbara and San Diego bay, which is increased in size to 20 miles by 15, and running north, whilst two others rival it in extent. A Russian chart published in 1848 has a bay and river on the east side of Point Duma. The geographical positions given previous to the Coast Survey operations are remarkably erroneous. We recollect well when coming upon this coast of finding in good nautical authority Point Conception over six miles distant from the latest determination in latitude; and we have heard of more than one vessel reaching California with only a school atlas for a chart!

In Findlay's Directory for the Pacific Ocean, published late in 1851, we find a description of the already mentioned San Juan island, but it does not give it a very definite location. It may not be uninteresting to state how the error has been perpetuated. The first notice we can find of this island is its discovery by Martinez, in 1789, on his passage from Monterey to San Blas. The next time it turns up is in Vancouver, vol. II, page 474, where the following account is given:

"At the distance of about eight leagues somewhere about N. 55° W., or N. 60° W. from Point de la Loma, by a very uncertain estimation, is situated an island called St. John's, between which and the coast we passed without seeing it, [although he previously states having seen San Clemente and Santa Catalina,] nor did we observe it while we remained at anchor, excepting on one very clear evening, when it was seen from the Presidio [of San Diego] at a time when I was unprovided with a compass or any other means of ascertaining its direction, and was therefore only able to guess at its situation.

"It appeared to be low and flat; is but seldom seen from the Presidio of San Diego, and was undiscovered until seen by Martinez, a few years before, in one of his excursions along the coast."

As Vancouver has plotted this island on the line from Point Loma to San Clemente, and as it is generally so placed, we have no hesitation in assuming that, during peculiar states of the atmosphere, the top of San Clemente or of Santa Catalina has been mistaken for another intermediate island.

Having visited and examined San Clemente, Santa Catalina, San Nicolas, Santa Cruz, and San Miguel, we found them offering no inducements for agriculture, and very few, indeed, for raising stock, while there are so many advantages on the main. In a few words, we may characterize their disadvantages as want of water, and want of fuel, with high, bold, and rugged sides, which in many places become precipitous. The surface of San Miguel and Santa Rosa is rolling, and covered with grass and bushes; the mountains of Santa Catalina almost inaccessible, and San Nicolas, and San Clemente, composed of coarse sandstone, presenting a dry, sandy, and sterile aspect.

On the chart of the coast from San Diego to San Francisco, published by the United States Coast Survey in 1853, a remarkable and beautiful exhibition of the parallelism between the islands and the adjacent coast is presented. The four islands, Anacapa, Santa Cruz, Santa Rosa, and San Miguel, with the rocks 7 miles W. by N. from the latter, lying broad off the coast between San Buenaventura and Point Conception, have their longer axes parallel to the trend of the shore-line, which is the general direction of the Sierra Concepcion immediately behind it. In Vizcaino's voyage, this parallelism was noted west of Santa Catalina, "where a regular row of islands exist, five or six leagues distant from each other, all populous, and the inhabitants trading with each other and the main; and the islands following each other in the same direction as the main land."

Cortez shoal, the islands of Santa Catalina, San Clemente, San Nicolas, with John Begg's rock, 7 miles from its northern extremity, have their longer axes NW. by W., and parallel to each other; whilst the island of Santa Barbara is on the prolongation of the longer axis of San Clemente. In the third parallel the direction becomes perpendicular to the first described, for from latitude 33° 05′ N. the trend of the coast and hills southward, through the longer axis of Point Loma, will pass through Los Coronados, although the islands lie NW. with respect to each other.

Navigators, in making the *Santa Barbara channel* from the northwest, readily estimate their approach in thick foggy weather by the peculiar odor of the bitumen which, issuing from a large pit on the shore about 8 miles west of Santa Barbara and floating upon the water, works *against* the summer winds far beyond Point Conception. This set to the westward is found to exist for about four miles off shore, and runs at a maximum velocity of a mile and a half per hour. Further out the current is variable, but even there its greatest velocity is attained when running to the westward. From Point Conception it strikes to the southward and westward, being doubtless influenced by a current from the coast.

Vancouver is the first who calls attention to the bitumen, in the following language, vol. II, page 449: "The surface of the sea, which was perfectly smooth and tranquil, was covered with a thick slimy substance, which, when separated or disturbed by any little agitation, became very luminous, whilst the light breeze that came principally from the shore brought with it a strong smell of tar, or of some such resinous substance. The next morning the sea had the appearence of dissolved tar floating upon its surface, which covered the ocean in all directions within the limits of our view, and indicated that in the neighborhood it was not subject to much agitation."

The following remarks of Sir Edward Belcher, in October, 1839, are taken from the Voyage of the Sulphur, vol. I, page 320: "Off this part of the coast to the westward [of Santa Barbara] we experienced a very extraordinary sensation, as if the ship was on fire, and after a very close investigation attributed it to a scent from the shore, it being more sensible on deck than below, and the land breeze confirming this, it occurred to me that it might arise from naphtha on the surface."

Among the islands, as far as San Nicolas, the current runs to the southward, and there remains little doubt that the steamship Winfield Scott was set out of her course and upon Anacapa by this current. On the Cortez shoal it frequently runs against the NW. wind at the rate of nearly 2 miles per hour. At other times it has been found to run in an opposite direction nearly as strong.

A preliminary chart of the eastern entrance to the Santa Barbara channel accompanied the annual report of the Superintendent of the Coast Survey for 1857.

It may not be here amiss to call attention to the abundance of mackerel found in the channel. We have seen the water fairly alive with them, and have caught them by hundreds. Cray-fish of very large size are found in great numbers along the shores.

The rainy season commences in the early part of November and continues until the middle of March. The quantity of rain that falls does not average over 15 inches. During that season SE. gales prevail, and sometimes during the summer months southerly weather will bring up heavy rain.

Commencing at the southward, the first object that claims our attention is the dangerous bank and rocks called the *Cortez shoal*, bearing about SW. ¼ W. from the southeast end of the island of San Clemente, and distant 50 miles. The extent of this bank has been sounded out carefully and found much greater than the early examinations led us to suppose. Within the limits of the 50-fathom curve the general trend is parallel with the islands of Santa Catalina, San Clemente, and San Nicolas, and it stretches about 17 miles, from latitude 32° 24′ N., longitude 118° 59½′ W., to latitude 32° 32′ N., longitude 119° 17½′ W., but curves slightly to the southwest. It has an average and nearly uniform width of 3½ miles. The nature of the bottom is hard, composed of white sand, broken shells, and fine coral at the southeast portion; and sand with broken shells at the northwest. The shoalest and most dangerous part is that known as the *Bishop rocks*, lying 5 miles from the southeast tail of the bank, and having but 2½ fathoms of water upon them. Around this danger the depth increases gradually, and in an extent of 2½ miles in the general direction of the bank reaches but 15 fathoms. The geographical position of these rocks is, approximately:

	°	′	
Latitude	32	25¾	north.
Longitude	119	05	west.

From the northwest end of the island of San Nicolas the rocks bear SE. ½ S., distant 57 miles; and from the southeast end of the island of San Clemente they bear SW. ¼ S., distant 46 miles.

The next shoal spot is one of 10 fathoms, about the middle of the bank, and of limited extent, being only half a mile square within the 15-fathom curve. Its geographical position is, approximately:

	°	′	
Latitude	32	26¾	north.
Longitude	119	10½	west.

From the northwest end of San Nicolas the spot last mentioned bears SE. by S., distant 54 miles; and from the southeast end of San Clemente it bears SW. ¼ W., distant 50 miles. From the Bishop Rocks it bears W. ¼ N., distant 5 miles.

To the northwestward of this latter shoal spot the depth is nearly uniform at 49 fathoms for 7½ miles, and between it and the Bishop Rocks the depth is uniform at about 43 fathoms.

Upon this bank the current is variable, frequently setting against the strong NW. winds with a velocity of nearly 2 miles per hour, and producing at all times a heavy swell, and even in moderate weather breaking heavily upon the rocks. In passing over the bank at night we have been sensible of our proximity to it by the increased swell. In the detailed examination of 1856 it was found that the general set of the current was to the southward and eastward, and the greatest velocity a mile and a half per hour; but no statement is made concerning the prevailing wind.

A chart of Cortez shoal was published in the Coast Survey report for 1856.

The existence of this bank had been reported several times, and the following positions were assigned:

Swift's island, latitude 33°; longitude 119° 06′, as seen by Captain Aulick, U. S. N.

Rock, latitude 32° 30′; longitude 119° 06′; no authority.

Bank, latitude 32° 28′; longitude 118° 42′; no authority.

It lies in the direct route now followed by the Panama and San Francisco steamships, and was discovered by Captain Cropper, of the steamship Cortez, in March, 1853. He says that the water around it was in violent commotion, and thrown up suddenly in columns at regular intervals of four or five minutes. At first he thought he saw breakers; and occasionally the water broke as on a reef, but he became confident the disturbance was owing to submarine volcanic agency. The specimens of the bottom negative this idea. He found his depth of water reduced from 42 fathoms to 9, which convinces us that he was on the shoal spot, about the middle of the bank, and saw the water breaking upon the Bishop Rocks, the same appearance that he witnessed having been seen many times since by others, and the nature of the rocky bottom and depth of water supporting the assumption. The position of the bank was afterwards closely determined by the commander of the steamship Pacific. The locality was gone over by a steamer, and no depth less than 42 fathoms found; but, upon a more minute examination being ordered, the 10 fathom spot was found, and the surveying schooner assigned to that duty was anchored on it five days.

Attention was subsequently called to a more extended examination of the vicinity by the clipper ship S. S. Bishop, (now Grey Eagle,) of Philadelphia, striking upon one of the rocks, since called by her name, (1855,) and, under unfavorable circumstances, two points of rock were supposed to exist, to which approximate positions were assigned. In 1856 the bank was sounded out to the extent of 130 square miles; and from a consideration of the highly favorable circumstances under which this last survey was made, confidence is expressed that the point of rocks above mentioned is the only one existing; but as it is very difficult to find detached single points of rock below the surface in a sea way, we shall not be surprised if others be eventually found. At all events the prudent navigator will give this bank a good berth. Its existence forcibly suggests the probability that other submarine ridges may lie parallel to the coast.

ISLAND OF SAN CLEMENTE.

This, like all the islands of the Santa Barbara channel, is high and bold, the southern end being the higher, and gradually falling to the northward.

The general trend of the island is NW. by W.; its length 17 miles, with an average and nearly uniform breadth of 4 miles, and 42 miles in circuit.

The southwest point of the island bears W. ½ S. from Point Loma, distant 60 miles. At the northwest end is a small indentation of the shore-line forming an anchorage, having a width of three-quarters of a mile, by half a mile in depth, with soundings decreasing from 12 fathoms, on the line of a large rocky islet at the NW. side to a point E. by S., to 4 and 5 fathoms close in shore. Kelp will be found in 10 fathoms, but the bottom is tolerably regular and hard. It is anything but a pleasant or safe anchorage in bad NW. weather, and even in heavy southerly weather the swell must roll in disagreeably. A hydrographic sketch of it was issued from the Coast Survey Office in 1852.

Under the SE. end of the island anchorage may be had in the deepest part of the indentation, but the bottom is rocky and irregular. The SE. point is a vast sandstone pyramid, and when it is brought to bear north, and the shore three-quarters of a mile distant, the anchorage will lie W. by N. ½ N. one and three-quarter mile inside the kelp, in 10 to 15 fathoms, and one-third of a mile from the narrow sand beach at the foot of the cliffs. Outside of the kelp the depth ranges from 10 to 30 fathoms.

This anchorage will afford protection in heavy northwest weather. A chart of it accompanies the annual report made for 1856 by the Superintendent of the Coast Survey.

The soundings around the island show a depth of from 36 to 130 fathoms close in shore, except off the northwest point, from which a reef makes out about a mile.

The Coast Survey secondary astronomical station was at the northwest anchorage, on the grassy rise, just inside of the high water line, and bore S. 17° E. from the north point of the rocky islet before mentioned. Its geographical position is—

	°	′	″	
Latitude	33	02	00	north, (approximate.)
Longitude	118	34	00	west.
	h.	m.	s.	
Or, in time	7	54	16.0.	

Neither wood nor water can be had here. The whole island appears unfit for raising stock, on account of the want of water. Very few trees are found, and the aspect is sterile.

This island was discovered by Cabrillo in 1542, and called by him San Salvador, after one of his two vessels. The present name was given by Vizcaino in 1602.

ISLAND OF SANTA CATALINA.

This island rises to a height of about 3,000 feet, and is remarkable for the great transverse break or depression, five miles from the northern end, running partly through it, and forming an anchorage or cove at each side. The land connecting these is very low, say not over 30 feet; but the hills rise up on each side two or three thousand feet, and, when sighted from the north or south, the whole appears like two very high islands. The view on the Coast Survey chart of 1852 shows this very beautifully, and is highly characteristic. The general trend of the island is W. by N. $\frac{3}{4}$ N.; its length $17\frac{1}{2}$ miles, with an average breadth of 4 miles to the southern part, and 2 miles to the northern, while the shore-line amounts to about 42 miles.

The depression in the island bears S.SW. from Point Fermin, and is distant $18\frac{1}{2}$ miles.

The harbor or cove on the southern side, 5 miles from the northern end, is only about one-third of a mile in width, but its approaches are bold, and, so far as known, free from hidden dangers. To find it, run along the SW. side of the island and make the depression; then stand in for the opening, keeping a little left of mid channel until a third of a mile inside of the heads. From thence keep in mid channel until abreast of the long, low point on the right, and anchor in 5 fathoms, soft bottom. There is a depth of 3 fathoms inside of the low point, with hard bottom, but not room enough for a vessel to swing. If the wind is blowing from the NW. vessels will lose it at the heads, and perhaps require to be towed in.

The anchorage on the north side of the depression is also small, with a reef in the centre and two large outlying rocks. A steamer could run in on the west side of the rocks, and anchor off the low beach in 10 fathoms, when the reef would lie N. by E. from her, distant an eighth of a mile. Small craft will here find protection from the prevailing winds, but experience difficulty in getting out, as there is always a swell setting in, and the wind blows in flaws and eddies on account of the high hills. Between the two points forming the anchorage the distance is half a mile, and the depth one-third.

The soundings around the island show bold water, from 19 to 75 fathoms, close in shore, with no outlying rocks except off the north cove. The shores are rocky, and on the southern side fearfully abrupt, but on the northern shore there are several indentations, where boats may land at almost any season. Deep and precipitous gulches are formed by the ridges of rock running diagonally across the island from NE. to SW., and occasionally a small valley varies the scene. Four or five settlers cultivate these spots, but their inconsiderable extent precludes the realizing of anything beyond a bare sustenance. About midway between the NW. extremity of the island and the great break there is a spring of good water, and at the SE. point good water has been obtained by sinking wells to a depth of fifty feet or more, but in the intermediate places water found at the same depth is brackish. There is a large pond on the low land between the two anchorages, but the water is very brackish. Scrub-oak is obtained for fire-wood, and a growth of thorny bushes covers the whole island, rendering travelling very difficult. The island was partially stocked with cattle and sheep, and at one time vast numbers of wild goats abounded, but they have helped to supply the California market with fresh meat.

From the north end of the near large rock at the north cove, the Coast Survey secondary astronomical station, which was on the edge of the bank, bore S. 25° W. Its geographical position is—

	° ′ ″
Latitude	33 26 34.7 north.
Longitude	118 28 45.0 west.
	h. m. s.
Or, in time	7 53 55.0.

This island was discovered by Cabrillo in 1542, and called by him La Victoria, after one of his two vessels. It received its present name from Vizcaino in December, 1602, when it was thickly inhabited by a people reported to be very ingenious, particularly in pilfering and concealing; some examples of which accomplishments they gave the Spaniards. Padre de la Ascencion, who accompanied this expedition, gives very particular descriptions of a kind of temple to the sun, with images and idols, found near the two coves.

ISLAND OF SANTA BARBARA.

This is one of the only two small islands of the Santa Barbara group. It lies on the line between the north end of San Clemente and the east end of Santa Cruz, and almost exactly halfway between them. From the north end of Santa Catalina it bears W. by S., distant 23 miles.

The extent of the island would not exceed two miles of shore-line; its elevation at the highest part is about 500 feet, and the top has an area of about thirty acres covered with soil, but no water is found, and not a vestige of wood. The shores are rocky and abrupt, presenting on the northeast and south sides perpendicular cliffs exposed to the full force of the ocean swell.

Landing is at all times difficult and dangerous. The water around it is deep, and there are no outlying rocks. Its approximate geographical position is—

	° ′
Latitude	33 30 north.
Longitude	119 02 west.

ISLAND OF SAN NICOLAS.

Of the channel islands this is the most distant from the coast, as well as the driest and most sterile. It is high, abrupt, and, like San Clemente, comparatively flat topped, but falling to the southern end. The sides are bold and precipitous, and composed of coarse sandstone.

Its general direction is W.NW.; its length is 8 miles, with an average and nearly uniform width of 3½ miles, whilst the extent of shore-line is about 22 miles.

The n●th point of the island bears SE. by E. from Point Fermin, distant 67 miles; the line passing one mile south of the island of Santa Barbara.

At the north end of San Nicolas heavy breakers make out two miles and a half, and the soundings towards Begg's Rock show irregular and rocky bottom. Breakers also extend from the southern point to the distance of a mile and three-quarters, according to Kellet. This is doubtless the case in heavy weather.

The soundings around the island show depths varying from 10 to 48 fathoms.

Off the southeast point, which is low and sandy, vessels may anchor in 10 fathoms, hard bottom, with a current running steadily to the southward, which makes the landing bad, as the surf cuts the beach at an acute angle.

The Coast Survey secondary astronomical station was on the sandy point just referred to, and its geographical position determined as follows:

	° ′ ″
Latitude	33 14 12.9 north.
Longitude	119 25 00.0 west.
	h. m. s.
Or, in time	7 57 40.0.

This island was not seen by Vancouver in 1793.

The Begg Rock is situated on the prolongation of the longer axis of the island of San Nicolas, bearing NW. by W. ½ W. from its nearest (NW.) point, and distant 7 miles. The rock is about 40 feet high, bold and well defined, and can be easily seen at a distance of ten miles. The soundings between it and the island indicate the existence of a submarine ridge connecting them. Its approximate geographical position is—

	° ′
Latitude	33 22½ north.
Longitude	119 39½ west.

It was named after the ship John Begg, which struck upon a reef near it, September 20, 1824, and was nearly lost. The foul bottom is covered with kelp. The position of the rock relative to the island of San Nicolas is shown on the general chart of reconnaissance published by the Coast Survey in 1852.

ISLAND OF ANACAPA.

This is, in fact, a curiously formed group of three islands, extending in a nearly E.NE. direction, their entire length being 5 miles. The west end of Anacapa is a peak 930 feet in height, with a base of over two miles by three-quarters of a mile. This is separated from the middle island by a gap ten feet wide, through which boats can pass. The middle island is nearly 2 miles long by 500 yards wide, whilst the eastern island is little over a mile long by 500 yards wide. The gap separating the middle and eastern islands is over 200 yards wide, but so completely filled with rocks as to be impassable for boats, which can, however, land on the north side of the island.

The west end of Anacapa is 4½ miles from the eastern point of the island of Santa Cruz, and bears E. ½ N. from it. The eastern end of the island bears SE. ¾ E. from the Santa Barbara light, distant 28 miles, and from Point Conversion SW. by W. 14 miles.

Anacapa is in latitude 34° 01′ N., and between longitudes 119° 19′ and 119° 24′ W. Upon it the *site for a light-house* has been recommended by the Superintendent of the United States Coast Survey.

The island is composed of coarse, dark gray sandstone, very rotten and crumbling. The sides are perpendicular, and from 250 to 300 feet high. The main peak is marked on the north side by several deep gulches, with almost vertical sides running from the summit to the bluff. The whole formation is filled with innumerable cavities, giving it the appearance of an enormous blackened honey-comb. At the eastern extremity is found a very beautiful arch in one of the outlying rocks. This is well shown in the view accompanying the Coast Survey chart of the vicinity of the island of Anacapa published in 1856. The soil is loose and thin, producing only a few dwarfed species of cactus and a thick-leaved succulent plant common to the seacoast in dry sandy localities. Not a drop of water is to be found on the island.

Anacapa is a place of great resort for the seal, sea lion, and formerly of the otter, but the latter have been nearly all killed off.

It was on this island that the steamship Winfield Scott ran ashore during a dense fog at midnight, December 2, 1853, in calm weather. The vessel was steaming at full speed, and ran between and upon the rocks with such force that she remained fast by the bow until heavy weather broke her up. The course of the steamer had been taken from Point Conception, but without a knowledge of the currents.

Vancouver, in his narrative, calls this island Enneeapah, and repeatedly mentions it by that name; but upon the chart of his survey and explorations it is engraved Enecapah, which has given rise to every variety of spelling. Old Indians at the present time pronounce it En-nee-ah-pagh′, with a very strong guttural intonation.

ISLAND OF SANTA CRUZ.

This island is the largest of the channel group, and lies broad off the coast opposite the town of Santa Barbara, at a distance of 20 miles. Its general direction is east and west, with a length of 21 miles and an average width of 4 miles, while the extent of its shore-line is not less than 53 miles.

On the northern side of the island, and near the middle, the shore makes a moderately deep curve, forming a roadstead called *Prisoner's Harbor*, at the opening of a valley, where plenty of wood and water can be obtained. Anchorage may be had a quarter of a mile off the middle of the beach in 15 fathoms, sandy bottom; but there is no protection from the heavy swell setting in with a northwester. It must, however, afford excellent refuge in southeast weather. A hydrographic sketch of the harbor was published by the Coast Survey in 1852.

The soundings around the island show deep water close to the shore; but there are rocks showing quite plainly one mile from the southwest point. A chart showing the hydrography of the eastern end of the island was published by the Coast Survey in 1856.

The island is bold, and about 2,500 feet in height. Its eastern part is extremely irregular, barren, and destitute of water; and the surface of the northeastern portion is thickly strewn with large angular pieces of stone, broken as if with a hammer. Several species of cactus and some of the coarse grasses flourish. The only wild animal found here is a small gray fox, of which there are great numbers.

Santa Cruz island is composed of coarse, dark gray sandstone, crumbling and rotten, like that of Anacapa.

The Coast Survey secondary astronomical station was on the eastern side of the fresh water. Its geographical position is—

	°	′	″	
Latitude	34	01	10.2	north.
Longitude	119	40	00	west.
	h.	*m.*	*s.*	
Or, in time	7	58	40	

From the Santa Barbara light we have the following bearings and distances:

East point of Santa Cruz island SE. $\frac{3}{8}$ S., distance 24 miles.

Prisoner's harbor S. by E. $\frac{1}{2}$ E., distance 22 miles.

West point of Santa Cruz island S. by W. $\frac{1}{2}$ W., distance 21 miles.

A site for a light-house at the eastern end of the island has been reported upon and recommended by the Superintendent of the Coast Survey to the Light-house Board.

This island was called Juan Rodriguez by Ferrelo, who commanded the ships of Cabrillo after his death, which took place either in Prisoner's harbor or in Cuyler's harbor, (island of San Miguel.) The greater probability rests with the former, as there they could obtain water, and oak wood for repairs, &c., while neither is to be had in the last mentioned harbor, except water during the rainy season.

The group comprising Santa Cruz, Santa Rosa, and San Miguel was discovered and called San Lucas by Cabrillo in 1542.

ISLAND OF SANTA ROSA.

This is the middle island of the group off the coast between Santa Barbara and Point Conception. Its general shape is that of a parallelogram, with the direction of the longer axis almost exactly east and west, and fifteen miles in length; and the shorter north and south, giving it a width of ten miles. The extent of shore-line is about 42 miles.

On the northwest side of the island, and midway between the north and west points, a reef extends out for a distance of a mile and a quarter.

There is a good passage between Santa Cruz and Santa Rosa, with a width of five miles, and one between it and San Miguel of four miles. Both passages are frequently used by the California and Panama steamships.

The soundings around the island do not show as deep water as around the others. On the northwest and northeast sides from fifteen to twenty fathoms are found two miles from shore, but on the southeast and southwest sides the water is much deeper.

The outline of the island is bold, but not so high as Santa Cruz. The hills are rolling, and covered with coarse grass and bushes. No harbors exist around its shores, which are steep and broken. The relative position of Santa Rosa in the group of the Santa Barbara islands is shown on the reconnaissance chart of the Coast Survey published in 1852.

The approximate geographical position of the south point of the island is—

	°	′	
Latitude	33	53	north.
Longitude	120	04	west.

For the western point we have—

	°	′	
Latitude	33	$58\frac{1}{2}$	north.
Longitude	120	$12\frac{1}{2}$	west.

On some early Spanish charts the western two of the Santa Barbara islands are called San Miguel and Santa Rosa, (naming the western first,) and upon others Santa Barbara and San Miguel. The present names and order are those adopted by Vancouver in 1793.

ISLAND OF SAN MIGUEL.

This is the western of the Santa Barbara Channel islands, its longer axis lying E. ½ N., and 7½ miles in length, with an average breadth of 2½ miles. The extent of shore-line is 21 miles. Its western extremity is bold and narrow, gradually increasing in breadth until it attains 3½ miles. The eastern face is nearly straight for 2 miles; the southern face is nearly straight along its whole length, with high, abrupt shores; and from 30 to 37 fathoms water are found close in shore. On the NE. side of the island is the small bay called *Cuyler's harbor*, off which lies a rock or islet more than a fourth of a mile long, and several hundred feet high. From this islet to the deepest part of the harbor the distance is a mile and a quarter, and the course SW. Close under the western side of the harbor is anchorage in 6 fathoms, secure from every wind except the north, which rarely blows here. The eastern part of the bay is full of rocks and reefs, and ought to be avoided. The reef in the middle of the bay bears SW. from the west end of the islet, and is distant half a mile. It is the same distance from the west point of the bay, near the anchorage, and bears E. by S.

A hydrographic sketch of Cuyler's harbor was published by the Coast Survey Office in 1852.

SW. by S. ½ S. from the west end of the islet is a rock, with rocky bottom distant a third of a mile; and, on the same line, another half a mile distant. The southern part of the islet is about half a mile from the east shore of the bay. The bay shores are high, steep, and rolling, and covered with coarse grass and bushes. There is no water here in summer, but during the winter water drains down the gully at the beach in the middle and southern part of the harbor.

The western point of the island bears S. by E. ¼ E., distant 25 miles from Point Conception, and SE. by S. ½ S., distant 35 miles from Point Arguello.

A *seacoast light* has been reported upon for this point of the island, and the subject referred to the Light-house Board.

Sheep and some stock have been placed upon San Miguel, but the success of the experiment has been doubtful—certainly unremunerative. A peculiar bobtail fox is found here.

The Coast Survey secondary astronomical station is on the SW. part of Cuyler's harbor, about forty feet up, on the side-hill. Its geographical position is—

	° ′ ″	
Latitude	34 03 00	north, (approximate.)
Longitude	120 20 27	west.
	h. m. s.	
Or, in time	8 01 21.8.	

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is IX*h.* XXV*m.* The mean rise and fall of tides is 3.7 feet; of spring tides 5.1 feet; and of neap tides 2.8 feet. The mean duration of the flood is 6*h.* 13*m.*, and of the ebb 6*h.* 5*m.* The average difference between the corrected establishment of the a. m. and p. m. tides of the same day is 1*h.* 40*m.* for high water, and 1*h.* 9*m.* for low water. The differences, when the moon's declination is greatest, are 2*h.* 54*m.* and 2*h.* 12*m.*, respectively. The average difference in height of these two tides is 1.6 feet for the high waters, and 2.5 feet for the low waters. When the moon's declination is greatest these differences are 2.6 feet and

3.6 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 5.8 feet, and when the moon's declination is greatest 6.8 feet. The highest high tide in the twenty-four hours occurs about *8h. 35m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about *3h. 51m.* before when south. The lowest of the low waters occurs about $7\frac{1}{2}$ hours after the highest high tide.

San Miguel was discovered by Cabrillo in 1542, and Cuyler's harbor is supposed by some to be the bay in which he wintered. He died January 5, 1543, having directed Bartolomé Ferrelo, his pilot, to assume the command of the expedition and continue the exploration as far north as possible. Ferrelo afterwards named the island in whose harbor his commander had wintered Juan Rodriguez.

Two rocks, showing themselves well above water, lie NW. by W. from the western extremity of San Miguel, the larger being distant 5 miles. It bears S. $\frac{1}{2}$ E., distant 22 miles, from Point Conception, and S.SE., distant 30 miles, from Point Arguello. Off the inner and smaller rock a reef extends a short distance to the southward and westward. Deep water is found around the rocks, and vessels may pass between them. The total extent of shore-line of the Santa Barbara islands is about 232 miles.

FROM POINT CONCEPTION, NORTHWARD.

The first headland to the northward of Point Conception is *Point Arguello*,* distant 12 miles, and bearing NW. by W. $\frac{1}{2}$ W. The shore is bold and compact, curving slightly to the eastward between the two points, and the mountains immediately behind are not less than 3,000 feet in height. Two or three hundred yards off Point Arguello are some detached rocks, upon which the steamship Yankee Blade struck and was lost. Near the same locality the steamship Edith was previously wrecked.

From this point the trend of the coast is NW. to Point Reyes, 240 miles distant, passing tangent to Point Sur in latitude 36° $19\frac{1}{2}'$ N., and inside the South Farallone Island light.

Eight miles north of Point Arguello a small stream empties into the ocean. It was considered by Vancouver the largest he had seen south of the Columbia, but it is insignificant and unimportant. He states that on the old Spanish charts it is called the Rio de San Balardo. On a recent Russian chart we find it called the river Benardo. On the Coast Survey charts it is designated *La Purissima.*

The first point northward of Point Arguello is *Point Purissima*, off which makes a reef about a fourth of a mile to the S.SW. This is known on the coast as *Point Pedernales*, signifying Point of Flints, but generally and erroneously printed Pedro Nales.

From Point Arguello N. by W. $\frac{3}{8}$ W., and distant 19 miles, is Point Sal,* which is marked by streaks of yellow sand, except at the extreme point. The extremity is formed by high, round, black rocks, off which are several sunken rocks, extending half a mile to the southward and westward. This stretch of the coast is very similar to that behind Conception and Arguello, but, after passing Point Sal, the mountains fall back, and the shore is formed of sand-hills. The general bend hence is north, until the shore commences sweeping westward to form the bay of San Luis Obispo, and the shores become high and abrupt.

The line of *equal magnetic variation* of 14° east cuts the coast line in latitude 35° 01′ N., and crosses the meridian of 121° 30′ W. in latitude 33° $55\frac{1}{2}'$ N. It moves annually southward about a mile and a half.

* So named by Vancouver in 1793.

SAN LUIS OBISPO.

This bay is an open roadstead, exposed to the southward, and even during heavy northwest weather a bad swell rolls in, rendering it an uncomfortable anchorage. The landing is frequently very bad, and often impracticable, but the best place is in the mouth of the creek, keeping the rocks at its mouth on the starboard hand. Fresh water may be obtained at a small stream coming up on the beach half a mile west of the creek. In the coarse sandstone bluff between these two places are found gigantic fossil remains.

Off *Point San Luis*, which forms the SW. part of the bay, are some rocks, and in making the anchorage vessels should give this point a berth of half a mile, passing in 6 to 8 fathoms; run on a N. by E. course, and anchor three-fourths of a mile from shore in 6 fathoms, sticky bottom; 4 fathoms can be got about a fourth of a mile from the beach. In winter anchor far enough out to clear Point San Luis, if a southeaster should come up. During southerly weather landing is frequently effected at the watering place, when impracticable at the creek.

A preliminary chart of the harbor of San Luis Obispo was issued from the Coast Survey Office in 1852.

The distance from the rock off Point San Luis to the mouth of the creek is a mile and a half; from the same rock to a white rock bearing N. 70° E. the distance is two and a quarter miles; and a black rock lies halfway between the white rock and the mouth of the creek.

The Coast Survey secondary astronomical station is on the bluff at the east side of the small fresh water stream, west of the creek, and its geographical position is—

	° ′ ″	
Latitude	35 10 37½	north.
Longitude	120 43 31	west.
	h. m. s.	
Or, in time	8 02 54.1.	

Magnetic variation 14° 17′ east in February 1854; yearly increase 1′.4

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is X*h.* VIII*m.* The mean rise and fall of tides is 3.6 feet; of spring tides 4.8 feet; and of neap tides 2.4 feet. The mean duration of the flood is 6*h.* 25*m.* and of the ebb 5*h.* 58*m.* The average difference between the corrected establishments of the a m. and p m. tides of the same day is 1*h.* 24*m.* for high water, and 1*h.* 0*m.* for low water. The differences when the moon's declination is greatest are 2*h.* 0*m.* and 1*h.* 28*m.*, respectively. The average difference in height of these two tides is 1.5 feet for the high waters, and 2.0 feet for the low waters. When the moon's declination is greatest, those differences are 2.0 feet and 3.1 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 5.4 feet, and when the moon's declination is greatest 6.1 feet. The highest high tide in the twenty-four hours occurs about 9*h.* 32*m.* after the moon's upper transit (southing) when the moon's declination is north, and about 2*h.* 54*m.* before when south. The lowest of the low waters occurs about 7 hours after the highest high tide.

The town of San Luis Obispo is not on the bay but is situated about ten miles in the interior, in the middle of an extensive and excellent grazing country. Communication is maintained with San Francisco and other ports by regular steamers and lines of sailing packets.

The bay was discovered by Cabrillo in 1542, and called by him Todos Santos.

To the northwest of the Bay of San Luis Obispo rises to a great height the *Monte de Buchon*, which is readily distinguished in coming from the northward or southward.

We have been informed by old otter hunters on this coast that there exists a sunken rock about 8 miles S.SW. from Point San Luis, and furthermore that they had found kelp upon it in 4 fathoms. On the old Spanish charts an island appears laid down in that direction, but distant about eight leagues. One of the Pacific mail steamships laid to in a southeast gale and thick fog, off Point Conception, and drifting to the northward came unexpectedly upon a sunken rock, upon which the sea was breaking heavily. The commander supposed the vessel to be then off Point Sal, and had so plotted the rock upon his chart, but upon being informed of the alleged existence of a rock off San Luis Obispo, he was satisfied that he had been near it, but unfortunately had no opportunity of determining his position.

This locality demands a thorough examination, as it is in the direct track of the whole California trade from San Francisco.

From Point San Luis the coast trends in a straight line W.NW., for a distance of 8 miles, and close along the shore of this stretch are several large rocks. Thence the coast trends abruptly to the north, running to the high conical rock called *El Moro*, distant 8 miles—these two shores forming the seaward base of Mount Buchon.

From El Moro the shore line gradually trends to the westward, thus forming a deep indentation or bay, called *Los Esteros* on the old Spanish charts, but designated as the Estero Bay on the Coast Survey chart. It was discovered by Cabrillo in 1542, and here he obtained wood and water. Behind El Moro are several lagoons or streams, and the high land retreats for some distance, leaving the shore low and sandy, while the north shore is rugged, and guarded by rocks. The NW. point of the bay is called *Punta de los Esteros* on the old Spanish charts, and bears NW. ½ N. from the west point of Mount Buchon, distant 13 miles. A line joining these two points shows that the bay is about 5 miles deep.

From Point Arguello, Punta de los Esteros bears NW. by N., distant 53 miles.

From Point Los Esteros to the western point of the anchorage of San Simeon the coast runs nearly straight NW. by W. for a distance of 15 miles. The shores are not so bold as to the southward or northward, and the mountains fall well back, leaving a fine rolling country of no great elevation, and well suited to agriculture. We have seen wild oats growing here over six feet in height—not one or two stalks, but in acres.

BAY OF SAN SIMEON.

This is a small exposed roadstead, but affords tolerably good anchorage during northwest winds. The southwest point of the bay bears NW. by W. from Point Esteros, and is distant 15 miles. The indentation of the shore line forming the bay trends between N.NW. to N. for half a mile, and then sweeps away to the westward about a mile and a half, gradually taking a southeast direction. The land behind the bay is comparatively low and gently rolling, the high hills retiring well inland.

Vessels coming from the northward may run boldly round the SW. point, within a few hundred yards of the shore in 8 or 9 fathoms, round up to north and anchor anywhere off the sand beach, in 5 fathoms hard bottom, and a little more than a quarter of a mile from shore. The beach is half a mile long, stretching well out, and rendering the landing disagreeable with any swell; but in such cases it is usual to land at the western part of the beach. Eastward of the sand beach the shore-line is bluff and guarded with rocks. Vessels from the southward must make short tacks close in shore or they will assuredly miss it. The only sure marks for it are the Piedras Blancas, as will be hereafter shown. It was in this bay that the steamship

Pioneer put in in a leaky state; was driven or dragged upon the beach, and after being abandoned by the underwriters was got off and carried to San Francisco. The bay affords not the slightest refuge in southerly weather. A hydrographic sketch of it was published by the Coast Survey in 1852.

In making this harbor from the northward vessels must sight the *Piedras Blancas*, (White Rocks,) four miles W. ¾ N. of the SW. point of San Simeon. They are two large white sharp-topped rocks, and nothing else like them is found on this part of the coast. The geographical position of the outer and larger rock is, approximately:

Latitude	35° 39′ north.
Longitude	121° 15′ west.

From Point San Luis they bear NW. ¾ W., distant 38 miles.

From Point Esteros they bear NW. by W. ½ W., distant 18 miles.

From Point Arguello the rocks bear NW. ½ N., distant 72 miles.

The secondary astronomical station of the Coast Survey at San Simeon is on the rise just off the beach, and bearing N. 5° W. from the SW. point of the bay. Its geographical position is:

	° ′ ″
Latitude	35 38 24.4 north.
Longitude	121 10 22 west:
	h. m. s.
Or, in time	8 4 41.5

This bay is supposed by some to be the "Bay of Sardines" of Cabrillo, where he anchored and landed in 1542.

From *Piedras Blancas* the coast trends NW. ½ W. for a distance of 57 miles, in an almost perfectly straight line. At a distance of 18 miles from these rocks the above mentioned bearing cuts a bold bluff and rounded point called *Punta Gorda*, off which, and for two or three miles along the shore northward, there are many rocks. This point is the Cape San Martin of Cabrillo. He placed it in latitude 37° 30′ N.; but, applying the correction obtained from his erroneous determination of San Diego, we obtain 35° 50′ N. as the position of San Martin, which is very nearly its proper latitude.

Continuing on the same bearing, and at a distance of 49 miles from Piedras Blancas, is *Point Sur*, sometimes called Lobos, making out nearly half a mile. As seen from the north or south, at a distance of 10 miles, Point Sur appears as a high, large, round-topped island; but upon approaching it a low neck of land is seen, connecting it with the main. Its approximate geographical position is:

Latitude	36° 19′ north.
Longitude	121° 52′ west.

Vancouver, in passing down the coast in 1793, thought this "small, high, rocky lump of land, lying nearly half a mile from the shore," was detached, and that it formed an island.

Still continuing on the same bearing, 57 miles from Piedras Blancas and 7½ miles from Point Sur, another slightly projecting point is passed, about a mile to the eastward of the course. Thence the coast trends more to the eastward, running N.NW. for eight miles, to *Point Cypress*, and passing *Point Carmel*, the south point of *Carmel bay*.

From *Point Arguello* to *Point Sur* the bearing is N. 44° W., and the distance 120 miles. *From Point Sur* to *Punta de los Reyes* the bearing is N. 43° W., and distance 118 miles.

The mountains, which have fallen back behind Los Esteros, gradually approach the shore-line north of San Simeon, and about 10 miles north of Piedras Blancas they come down abruptly to the coast, and run parallel with it to Point Carmel, forming the boldest and most complete shore that we have yet passed, and attaining a uniform elevation of nearly 3,000 feet. These mountains were called by Cabrillo the "Sierras Altas," but at present the range is known as the *Sierra de Santa Lucia.* From their abrupt faces we have seen cascades falling down a height of forty or fifty feet directly into the sea.

CARMEL BAY.

Between Point Carmel and Point Cypress, which are about 3 miles apart, lies the small rocky and unsafe bay of Carmel. At the southern extremity is a small cove sufficiently land-locked and protected for small vessels. In the vicinity there is an extensive quarry of granite, and several small coasting vessels are employed for its transportation to San Francisco; but there is so little space that they are compelled to warp in and out by buoys placed at the entrance. Point Cypress, the north point of the bay, is low and covered with cypress to the water, and is the first wooded point met with in coming from the southward. The upper branches of the trees are spread out by the influence of the strong prevailing winds, and present a flat or umbrella-like appearance.

The Mission del Carmelo is situated but a short distance from the shores of the bay, and can be seen from the water in certain directions. After the abolishment of the Society of Jesus, in Lower California, by the emperor Charles III of Spain, with the transfer of the administration of the Missions to the Dominican monks, and of the property to the Franciscan order, the Visatador, Don Josef de Galves, of the latter order, in July, 1768, visited San Diego and Monterey, for the purpose of establishing Missions. In 1769 he founded that of San Carlos de Monterey, now usually called the *Carmel Mission.*

The name Rio Carmel was applied to the small stream emptying into Carmel bay, by Vizcaino, in December, 1602.

From Point Cypress to Point Pinos the general direction of the shore is N. $\frac{3}{4}$ E., and the distance four miles.

Point Pinos makes out as a low rounding point, bringing the pines, with which it is covered, within a quarter of a mile of the shore, off which the rocks make out a quarter of a mile, and the line of 3 fathoms nearly half a mile, when the depth suddenly increases to 10 or 15 fathoms, and at a mile reaches 40 or 45 fathoms. The 3-fathom line follows the shore within a third or half a mile into Monterey, whilst outside of that line the depth increases as suddenly as off the point. Vessels should always give Point Pinos a good birth, as a very heavy swell almost invariably sets upon it. This point is the northern termination of the long and elevated range called Sierra de Santa Lucia, extending southward and forming the bold rocky coast-line to San Luis Obispo. Upon the northwestern part of the point, at the face of the growth of pines, is situated the *Point Pinos light-house.* The building is a grey granite dwelling one story in height, surmounted by a tower and lantern. The illuminating apparatus is of the third order of Fresnel, and shows a *fixed light of the natural color* from sunset to sunrise. It will illuminate about four-fifths of the horizon, and is elevated fifty feet above the level of the sea. During ordinary clearness of the atmosphere it can be seen from an elevation of—

10 feet, at the distance of 12 miles.

20 feet, at the distance of 13 miles.

30 feet, at the distance of 14 miles.

Its geographical position, as determined by the triangulation of the Coast Survey, is:

	° ′ ″
Latitude	36 37 58.1 north.
Longitude	121 55 00 west.
	h. m. s.
Or, in time	8 07 40.0.

The primary astronomical station of the Coast Survey is about half a mile eastward of the light, and has the following geographical position:

	° ′ ″
Latitude	36 37 59.4 north.
Longitude	121 54 25 west.
	h. m. s.
Or, in time	8 07 37.7.

Magnetic variation, 14° 58′.3 east, in February 1851, with a yearly increase of 1′.4.

A topographical sketch of Point Pinos is given in the annual report of the Coast Survey for 1851.

BAY OF MONTEREY.

Point Pinos forms the southwest point of this bay, and *Punta de la Santa Cruz*, west of the town and anchorage of Santa Cruz, the northwest point. A line joining these two points runs NW. by N. ½ N. 19 miles, and the greatest width of the bay, near the mouth of the Salinas river, nine miles.

From Point Pinos to the anchorage off the town of Monterey, the course is E. by S. ½ S., and the distance three miles. The shore towards the town is rugged, composed of granite, and covered with a heavy growth of fir; but to the eastward of the town is a long, sandy beach, backed by sand dunes of slight elevation. Off this beach the line of three fathoms lies at a distance of about half a mile, the water deepening rapidly beyond that, and the bottom everywhere hard.

Vessels coming from the northward, bound to Monterey, follow the coast from *Point Año Nuevo* to Point Santa Cruz, then run well into the bay, but not too far, for fear of losing the wind, and to avoid the set of the heavy swell rolling towards the beach. Leaving Point Santa Cruz, run on a SE. by E. course about 14 miles; thence a S. course for 8 miles will bring vessels to the anchorage. These precautions are necessary, because Point Pinos, with the whole bay, is almost continually inveloped in a dense fog. Very frequently the coasting steamers have to run for the beach, and then follow the route to the anchorage.

When the California mail steamships stopped at Monterey they frequently ran outside of Point Pinos, or in very dangerous proximity to it. This led to their firing a gun when approaching the harbor during foggy or dark weather, and upon the report being heard at the fort a gun was fired in answer, and the exchange kept up until the steamer was safe at her anchorage. We were encamped at Point Pinos when the steamship Carolina was brought in by this means, after she had got nearly as far down as Carmel bay. A direct course from Point Año Nuevo to the anchorage is SE. ½ E., and the distance 36½ miles. From Point Pinos to Point Año Nuevo the bearing is N. 47° W., and the distance 34 miles.

By anchoring well in at the western side of the anchorage vessels will avoid much of the swell that comes in with the heavy northwest winds, but never sufficient to make any berth there dangerous. In heavy southerly weather Point Pinos breaks the swell, but the wind draws very strong over the anchorage. The water shoals from 15 to 3 fathoms in a distance of

300 yards, and the lead should be used to avoid running in too far. A chart of the bay was published by the Coast Survey office in 1857.

The approximate geographical position of the end of the wharf, abreast of the custom-house at Monterey, is:

	°	′	″	
Latitude	36	36	17	north.
Longitude	121	52	27	west.
	h.	*m.*	*s.*	
Or, in time	8	07	29.8	

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is X*h.* XII*m.* The mean rise and fall of tides is 3.4 feet, of spring tides 4.3 feet, and of neap tides 2.5 feet. The mean duration of the flood is 6*h.* 31*m.*, of the ebb 6*h.* 2*m.*, and of the stand 0*h.* 35*m.* The average difference between the corrected establishment of the a. m. and p. m. tides of the same day is 1*h.* 44*m.* for high water, and 1*h.* 2*m.* for low water. The differences, when the moon's declination is greatest, are 2*h.* 40*m.* and 1*h.* 28*m.*, respectively. The average difference in height of these two tides is 1.4 feet for the high waters, and 2.4 feet for the low waters. When the moon's declination is greatest these differences are 2.2 feet and 3.7 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 5.3 feet, and when the moon's declination is greatest 6.3 feet. The highest high tide in the twenty-four hours occurs about 9*h.* 36*m.* after the moon's upper transit, (southing,) when the moon's declination is north and about 2*h.* 50*m.* before when south. The lowest of the low waters occurs about 7 hours after the highest high tide.

The town of Monterey presents a very pretty appearance as seen from the water. Immediately behind it the country rises in plateaux, diversified by hill and valley, and beautifully dotted by oak groves.

A Portuguese company has been formed here to engage in the whale fishery, and even with inadequate means it succeeded in obtaining over 16,000 gallons of oil (which sold for $12,000) in less than a year.

Regular communication is kept up with all parts of the coast by steamers and numerous sailing vessels. Stages communicate with Santa Cruz and all the towns to San Francisco.

The Bay of Monterey was discovered by Cabrillo in 1542, and called the Bay of Pines. It was surveyed by Sebastian Vizcaino in 1602, and the name was changed to Puerto de Monte-rey, in honor of the Spanish viceroy of Mexico, Don Gaspar de Zuniga, Count de Monte-rey, who despatched the expedition.

Following the shore from the town of Monterey northward it presents a uniform sand beach running nearly north, backed by low dreary sand dunes, producing sparsely the coarsest grasses and bushes, and entirely destitute of fresh water. This waste extends to the *Salinas river*, of which we reach the great bend at about 9½ miles from Monterey. From Point Pinos it bears N. 30° E., distant 8½ miles. From this bend the river follows the line of the beach, just inside of the low sand dunes, for a distance of 4 miles, and then disembogues. From Point Pinos it bears N. 18° E., and is distant 12½ miles. This river has been designated by a variety of names—as Buenaventura, Monterey, and Salinas; but it is now generally known by the latter. From its mouth to the entrance of the *Rio del Pajaro*, or San Antonio, is 2¼ miles, the shore trending to the N.NW., and the entrance to that river bearing N. 11° E. from Point Pinos, distant 14 miles. From here the coast runs NW. nearly straight to *Ortos creek*, a distance of 7 or 8 miles, and about 6 miles E. by N. of Santa Cruz, with the shore rocky and abrupt.

North of the Salinas river commence rich meadow and table lands, affording to the settler spots unsurpassed for productiveness, even in the prolific State of California.

An extensive valley, called the Salinas plains, extends inland from the eastern part of Monterey bay, nearly to the Mission of San Miguel, situated on a plateau of the San Bruno mountains. This valley is said to be nearly 90 miles in length, and in breadth varying from two to ten. It contains some 200,000 acres of good agricultural lands, and the remainder affords excellent pasturage for horned stock, horses, and sheep.

The line of *equal magnetic variation* of 15° east cuts the coast line of Monterey bay in latitude 36° 45′ N., about half way between the great bend and mouth of the Salinas river, and crosses the meridian of 123° 0′ W., in latitude 36° 36′ N. This line moves annually southward about a mile and a half.

SANTA CRUZ HARBOR.

This harbor or anchorage is at the northwest part of the bay of Monterey, and is of very limited extent. It is protected from all the winds from the northward, but exposed to the full sweep of southerly gales, and many coasters have been driven ashore during the winter season. It is about three quarters of a mile in depth northward, by 1½ mile east and west.

Vessels coming from the northward, after leaving Point Año Nuevo, follow the coast line on a general course E.SE. for about 18 miles. The shore for this distance is abrupt, jagged, and moderately elevated, with a range of high hills, or mountains, whose summits are almost continually enveloped in fog. Skirting the shore at a distance of half a mile a depth of 6 to 10 fathoms can be carried, and upon making Point Santa Cruz, the top of which is moderately level for some distance back, 4 fathoms are obtained within a quarter of a mile of it; round up and run along in 5 fathoms until abreast of the beach, where good anchorage will be found half a mile from shore.

Vessels from the south in summer keep well into Monterey bay, to escape the full force of the northwesters and the heavy head sea.

During the winter months anchor well out, so as to be able to clear the shore westward of Point Santa Cruz in case a southeaster springs up.

Landing on the beach is generally disagreeable, as it extends out some distance, but boats usually land at the Embarcadero, at the foot of the bluff in the NW. part of the harbor.

The beach is over half a mile in length, and between its eastern extremity and the bluff point empties the San Lorenzo river, a small stream running past the town and mission, which is situated a mile inland.

A hydrographic sketch of the harbor was published in the Coast Survey report for 1854.

The country about Santa Cruz is exceedingly productive, and now thickly settled. A steamer runs regularly in the trade between this place and San Francisco, and numerous coasters find abundant freight from here and the Pajaro country to San Francisco.

Regular stage communication is maintained with San Francisco and Monterey.

The secondary astronomical station of the Coast Survey was at the top of the bluff at the Embarcadero. Its geographical position is—

	° ′ ″
Latitude	36 57 26.9 north.
Longitude	122 00 10 west.
	h. m. s.
Or, in time	8 08 00.7

An examination for the location of a *harbor light* has been made, and the site recommended to the Light-house Board by the Superintendent of the Coast Survey.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is X*h.* XVIII*m.* The mean rise and fall of tides is 4.1 feet; of spring tides, 5.5 feet; and of neap tides, 2.9 feet. The mean duration of the flood is 6*h.* 47*m.*; of the ebb, 5*h.* 45*m.*; and of the stand, 0*h.* 20*m.* The average difference between the corrected establishment of the a. m. and p. m. tides of the same day is 1*h.* 44*m.* for high water, and 1*h.* 2*m.* for low water. The differences, when the moon's declination is greatest, are 2*h.* 40*m.* and 1*h.* 28*m.*, respectively. The average difference in height of these two tides is 1.4 feet for the high waters, and 2.4 feet for the low waters. When the moon's declination is greatest these differences are 2.2 feet and 3.7 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 6.0 feet, and when the moon's declination is greatest, 7.0 feet. The highest high tide in the twenty-four hours occurs about 9*h.* 32*m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about 2*h.* 54*m.* before, when south. The lowest of the low waters occurs about 7*h.* after the highest high tide.

It was off Point Santa Cruz that Cabrillo is supposed to have anchored on the 17th of November, 1542, upon his return from the northward.

From Point Santa Cruz to *Point Año Nuevo* the distance is 18 miles, and the general direction W. by N. ¾ N., at first curving to the southwestward of that course, and then to the northward until within 3 miles of the rock of Point Año Nuevo, when the shore curves well to westward, (for the last mile to the southwest,) forming an anchorage protected somewhat against the heavy swell from the northwest, and having a depth of five fathoms within less than half a mile of the shore, and from 10 to 15 fathoms at the distance of a mile.

At a quarter of a mile from the point lies a black jagged islet, consisting of a sloping ledge of rocks covered with a stratum of yellow clay about four feet thick, and this again covered with a mound of sand about 30 feet high. Upon this the erection of a *light-house* has been recommended. The point itself is composed of rolling hills of shifting sand, varying from 20 to 100 feet in height, while behind them rises the Santa Cruz range of mountains. The coast trail, which followed the beach from the southward, here strikes up the hills behind the sand dunes.

A sketch of the point is given in the Coast Survey report for 1854.

Between Año Nuevo and the valley of the Pescador, (a small stream running through a valley of inconsiderable extent,) the general formation of the seaboard is that of a table-land of three terraces, the lowest gradually sloping from the base of the second to the coast, which is exceedingly rocky and forbidding. The underlying stratum is sandstone. The country between the valley of the Pescador and that of the San Gregoria (another small stream) undergoes a striking change, both in the character of its topography and its geology. Instead of the table-land we meet with a spur of the coast hills, running into the sea, and having an elevation of 300 feet. The shore-line and the country generally present a very broken and rugged appearance, occasioned by the deep gulches that cut through to the ocean.

From Point Año Nuevo to the Bell Boat, outside of the bar off the entrance to San Francisco bay, the distance is 40 miles, and the course NW. by N. Ten miles from the point this line passes tangent to *Point Miramontes*, the shore being compact and tolerably straight until it reaches Miramontes, where a contracted anchorage exists, called Half Moon bay, whence small coasters carry the agricultural produce of the country to San Francisco.

Continuing on this course (NW. by N.) 30 miles from Point Año Nuevo, the prominent headland called *Point San Pedro* is passed at a distance of two miles. This point is a black, abrupt, rocky promontory, over 500 feet high, having large, high, jagged rocks at the northern part, and is an excellent mark for making the entrance to San Francisco bay. At the last position off San Pedro the bell boat on the bar is distant about 12 miles. From the bell boat, *Fort Point* (two miles inside the south head formed by *Point Lobos*) is on with *Alcatraz island*, inside of the harbor. Fort Point and Alcatraz island have *Harbor Lights* upon them, and are the fair way line for crossing the bar. The rock off *San Pedro* is nearly a hundred feet high. Its south face is white and shows the line of stratification plainly. From the west the dip of the strata shows about 60 degrees to the northward. It is connected with the main by some low rocks. Half a mile to the northeast of the point is the valley of San Pedro.

The range of mountains forming the northeastern shore of Monterey bay and extending to Santa Cruz and Point Año Nuevo is called Santa Cruz. Thence northward to the *Golden Gate*, and forming the peninsula of San Francisco by bounding the bay on the west, the mountains are known as the San Francisco or San Bruno range.

The extent of shore-line from Point Conception to *Point Boneta* is about 286 miles.

BAY OF SAN FRANCISCO AND APPROACHES.

This bay affords the finest and most commodious harbor on the Pacific coast of the United States. From its discovery it has commanded the admiration of navigators, and since the wonderful rise of California has well sustained its reputation. Its geographical position, its size and depth of water, its noble entrance and bold shores, the Sacramento and tributaries, draining the rich agricultural valleys and auriferous slopes of the Sierra Nevada, the magic city upon its shores, and the salubrity of its climate, have conspired to make it emphatically the port of the Pacific.

The Golden Gate is the entrance to the bay, and presents the character of a great cleft or fissure in the sea coast range of mountains, thereby connecting the Bay of San Francisco with the Pacific Ocean. On approaching, it is difficult to imagine that a deep channel lies ahead, so clear is the atmosphere and so well defined the Contra Costa mountains behind the bay. Both shores are bold, broken into points, and rocky; but the northern is much the bolder, rising almost perpendicularly from the water, attaining an elevation of about 1,000 feet, but a short distance back, and in 7 miles rising to 2,600 feet. On the south side, between the points, are stretches of low beach; the hills are undulating and of moderate elevation, increasing very gradually in altitude to the southward, and reaching a height of 1,200 feet in about six or eight miles. The chart of San Francisco entrance, which accompanies the Annual Coast Survey Report for 1856, shows the bold and characteristic topography of the vicinity of the Golden Gate.

Point Boneta.—The north head of the entrance is formed by this point; a narrow, precipitous, rocky cape, nearly 300 feet high, and stretching from the *Light House* about half a mile to the SE. Behind it the mountains rise rapidly to an elevation of 1,500 feet. There are no dangers off the point, the line of 3 fathoms rarely extending 300 yards from any portion of it. When the clipper ship San Francisco was lost on this head, we are told that she first struck the *bluff* on the inside of the point, was carried by the currents around the point, and then cast ashore on the outside. The reef, or line of sunken rocks, stretching out three-quarters of a mile upon some maps, has no existence, and only serves to mislead those unacquainted with the locality. From 5 to 6 fathoms can be found on every side of it within a fifth of a mile.

One mile and seven-eights NW. of the point the steamship Tennessee went ashore whilst endeavoring to find the entrance in a thick fog, (calm weather,) and was lost. The Cortez had got in just before her, and as the fog was shutting down over the entrance.

Light-house at Point Boneta.—The building is situated nearly half a mile from the extremity of the point, and consists of a brick tower painted white, and surmounted by a lantern painted black. From seaward it is seen projected against the dark, high hills behind it, and in clear weather is a very plain object. The illuminating apparatus is of the second order of the system of Fresnel, was first exhibited April 30, 1855, and shows a *fixed light of the natural color* from sunset to sunrise. It illuminates five sixths of the horizon, and is elevated about 306 feet above the level of the sea. During ordinary conditions of the atmosphere it can be seen from an elevation of—

10 feet at a distance of 23.6 miles.
20 feet at a distance of 25.1 miles.
30 feet at a distance of 26.3 miles.
50 feet at a distance of 28.1 miles.

Its geographical position, as determined by the triangulation of the Coast Survey is—

	°	′	″	
Latitude	37	49	10.0	north.
Longitude	122	30	50.3	west.
	h.	m.	s.	
Or, in time	8	10	03.4.	

Magnetic variation 15° 27′ east in 1852.

From the light at Point Boneta to that on Fort Point the distance is 2⅗ miles, and bearing E. ¼ N.

Fog-bell at Point Boneta.—The bell, with the machinery, is in a frame building, open in front, and placed on the bluff just in advance of the light-house tower, at an elevation of 270 feet above the level of the sea. The bell weighs 1,500 pounds, and during foggy and thick weather is struck six blows, at intervals of sixteen seconds each, followed by a pause of forty-four seconds.

The fog-gun at Point Boneta has been discontinued since the placing of the *bell-boat* outside the bar, March 18, 1858. It may not, however, be amiss to state here the design of the fog-gun. A twenty-four pounder was placed near the *light-house*, and during fogs or thick weather, either day or night, was fired at the hours and half hours of San Francisco mean time. It enabled vessels, before reaching the bar, to get the bearing of Point Boneta, and, by the loudness of the report, or better, by the soundings, to form an estimate of their distance from it.

We advocated this plan strongly soon after our arrival upon the coast, and it met with the hearty support and commendation of officers of the navy and commanders of the steamships, clippers, and coasters. Continuing to urge its adoption until the spring of 1855, we had the satisfaction of seeing it tried in August of that year. We have since learned, by British newspapers, that the Board of Trade and Liverpool Corporation have placed a gun of large calibre on Holyhead, to be fired during foggy weather, for the benefit of mail steamers passing up the Irish channel.

Point Lobos.—The south head of the entrance to San Francisco bay is formed by this point, upon which Congress authorized the erection of a *light-house*, where a light has been regularly shown and a fog-bell kept in operation by private enterprize. Upon the round-topped hill behind the point is erected a large frame building for a telegraph station, whence the electric wires run to the city of San Francisco. Southward of the head the sand dunes are conspicuous and easily recognized features in approaching the entrance. The strong northwest summer winds, drawing in over the land, raise the white sand from the three miles of broad beach, and carrying it inland over the hill tops, bury grass, bushes, and scrub oak. The quantity of sand driven in from this beach is enormous, and its accumulation has greatly modified the topography of the peninsula.

The geographical position of the site selected for the *light-house*, as determined by the triangulation of the Coast Survey, is—

	°	′	″	
Latitude	37	46	56.9	north.
Longitude	122	29	39.5	west.
	h.	*m.*	*s.*	
Or, in time	8	9	58.6	

This position is 32 feet north and 1,317 feet west of the outer telegraph station.

Off the western face of Point Lobos lie a number of black jagged rocks about 50 feet high, but all within the 5-fathom line, and close in shore. They are called the *Seal rocks*, and one of them shows a large arch from particular directions. The outer one bears from Point Boneta SE. by S. ¼ S., and is distant 2⅛ miles. From it the general trend of the shore runs in a line to Fort Point for nearly a mile, to a short jutting high point, off which lie the *Mile rocks*. From this point the shore runs well to the eastward for a mile, gradually trending to the north for a mile and a half to Fort Point. In the deepest part of this bend the shore is low, with small hillocks rising from the general surface and slope of the hills, and fronted by a long sand beach.

Mile Rocks.—These two rocks lie off Point Lobos, a short distance within the limit of the entrance of the Golden Gate. They are small, near each other, and have a height of 15 feet above water, with a good depth of water all around and close to them; but the current swirls and eddies about them in such a manner as to render a near approach anything but agreeable or safe with a light wind. The inner and smaller rock is one-third of a mile from the small jutting point inside of Point Lobos, and very nearly 2 miles from Fort Point. Vessels running in on the line Fort Point and Alcatraz island pass less than half a mile from the outer and larger rock. The rocks bear almost SE. from Boneta light. They were called "One Mile rocks" by Beechy in November, 1826.

Fort Point.—This was formerly a bold, narrow, jutting promontory of hard serpentine rock, 107 feet above high water, and surmounted by a small Mexican fortification, called Fort Blanco. The view from the point was one of the finest in the harbor; but the whole headland has been cut down to within a few feet of high water, and increased in area to form a large fortification, which will be mounted with guns of the largest range and calibre. Upon the hill side rising behind it are houses for the accommodation of the commandant, officers, soldiers, and workmen. Eastward of the point is a long substantial wharf, constructed for receiving stores, ordnance, &c.

Several large vessels have been lost on Fort Point by venturing too close during light airs and strong irregular currents.

The light-house at Fort Point is a wooden building, painted white, and situated outside of the fortifications. The illuminating apparatus is of the fifth order of Fresnel, and shows a *fixed light of the natural color* from sunset to sunrise. It is 52 feet above the level of the sea, and, during ordinary states of the atmosphere, can be seen from an elevation of 15 feet at a distance of 12½ miles. The angle of visibility seaward is bounded by the extremity of Point Boneta, bearing W. ¾ S., and Point Lobos, bearing SW. by S. ¼ S.

The geographical position, as determined by the triangulation of the Coast Survey, is—

	°	′	″	
Latitude	37	48	37.4	north.
Longitude	122	27	37.8	west.
	h.	m.	s.	
Or, in time	8	9	50.5	

The light-house first built upon the high point was taken down when the fortification operations commenced. The light in the present one was first exhibited March 21, 1855.

The South Farallone light is visible from a vessel's decks when abreast of Fort Point.

Fog-bell at Fort Point.—The color of the structure is white, and may be seen at a distance of 12 nautical miles. Its height is 36 feet, and the elevation of the light (5th order) 52 feet above the sea level. The bell is struck by machinery, and the fog-horn sounds every five minutes.

BELL-BOAT OUTSIDE OF SAN FRANCISCO BAR.

A bell-boat is placed just outside of the bar, in 15 fathoms at mean low water, on the range of the Fort Point and Alcatraz island light-houses. It is 30 feet long, painted red, and furnished with a day-mark of 3½ feet by 4, elevated 8 feet above the water. The bell weighs 500 pounds, is elevated 15 feet above the water, is rung by the action of the sea, and under ordinary circumstances of wind and sea should be heard from one to three miles. Mariners are cautioned not to run into or damage this aid to navigation. The fog-gun signal at Point Boneta was discontinued with the placing of this bell-boat, March 18, 1858, as already stated; and the bar buoy on the same range was also removed.

The approximate geographical position of the bell-boat is—

	°	′
Latitude	37	45½ north.
Longitude	122	38½ west.

The bearings and distances of prominent objects from it are as follows:

South Farallone Island light-house, SW. by W. ½ W., 16½ miles.

Punta de Los Reyes, (light-house site,) NW. by W. ⅜ W., 22¼ miles.

Duxbury Point, NW. by N. ½ N., 8½ miles.

Point Boneta light-house, NE. ¼ N., 7¼ miles.

Fort Point light-house, NE. ¾ E., 9¼ miles.

Point Lobos telegraph station, NE. by E. ½ E., 7¼ miles.

Point San Pedro, SE. ¼ E., 11¼ miles.

The course to enter the bay from it is NE. ¾ E., and it will be seen that it lies almost in the line from the S. Farallone light to the proposed Point Lobos light.

San Francisco bar.—The bar off the entrance to the bay of San Francisco has a depth of 5 fathoms at the lowest tides. Its general form is that of a horse-shoe, commencing 4 miles southward, stretching out gradually to 6 miles abreast of Point Lobos; and when nearly up to the parallel of Point Boneta running inshore towards that point and forming the "four-fathom bank," from a distance of 4 miles down to 1. The average breadth of the bar within the limits of the 6-fathom curve is about one mile. It falls off outside to 10 fathoms in half a mile, and deepens gradually inside. Not lest than 5 fathoms exist over the bar when Point Boneta light bears between NE. by E. ½ E. and N. by W. ½ W.

No vessel should anchor upon the bar if she can possibly avoid it; frequently a heavy swell sets in without wind, and if the current is running strong ebb, it allows little chance of escaping from an uncomfortable berth.

It has been given as a rule for steamers approaching in thick weather to run for the bar as nearly as they can estimate, keeping the lead going until they strike 5 fathoms, and run on until the depth is increased, when the armed lead should bring up gray sand with red specks, and they may conclude themselves within the bar.

A line of large buoys, properly marked, outside the bar in 10 fathoms is the next best expedient after a large fog-gun. From them the position of the bell-boat could be known; and numbered buoys from it across the bar would enable steamers in thick weather to feel their way in and be independent of guessing about the velocity and direction of the current.

The fog sometimes stands like a wall outside of a line from Fort Point across the entrance, while the bay inside is beautifully clear. After the greatest heat of the day is passed this fog creeps in and envelopes land and water.

The shores of the Golden Gate.—On the north side of the Golden Gate the shores are very precipitous, with an occasional short stretch of sand beach at the base of the bluffs, affording a boat landing. *Point Diablo* is the first point inside Boneta, and bears NE. by E. ¾ E. distant 1¼ mile from it; between these the shore is indented about three-quarters of a mile, affording a boat landing for the light-house people. In the vicinity of Diablo the faces of the cliffs show of a reddish purple color. The rock is very hard and flinty, "traversed by seams of quartz, and has a banded or belted structure, so that it resembles varieties of jasper. * * * * * It exhibits its stratified character most distinctly. It is also found at the cinnabar mine of New Almaden."

The red specks found on the bar are doubtless derived from the disintegration of these reddish cliffs.

From Diablo the shore is jagged and irregular to Lime Point Bluff, distant one mile, and bearing NE. ¾ E. Off this point are several high rocks, but they are so close to the bluff as to be distinguishable only from certain directions. From Lime Point Bluff to Fort Point the distance is barely a mile, and the bearing S. by E. ¾ E. This is the narrowest part of the Golden Gate. From thence the bay begins to open well to the northeast.

On the south side, eastward from Fort Point, the shore is low, flat and marshy to *Point San José*, distant 2½ miles, and bearing E. by N. This point is moderately high, with a few houses clustering upon it. Off this reach was the "outer anchorage" of former navigators, and the Presidio of San Francisco is seen a short distance behind it.

"It is a curious and interesting fact that the sand beach between Fort Point and Point San Josef has been thrown up by the surf upon an extensive alluvial deposit, which has the character of a peat bog or swamp. When the tide is very low the edge of this peat formation may be seen. Large masses of the peat are also broken out during storms, and thrown up on the sand of the beach. This sand and all the loose round boulders, from three to eight inches or more in diameter, rest upon a foundation of the peat; and the continuation of the peat is found in the swamp or flat meadow land which lies inside the belt of sand, and between it and the base of the sandstone hills. It is very difficult to account for the formation of this swamp under conditions like those at present existing."

"A strong current is constantly setting back and forth through the channel, and the action of the surf constantly undermines and encroaches upon the beach, so that the present action is destructive, and the swamp could not possibly have been formed while the Golden Gate was open as we now find it." These remarks are taken from a geological report of the coast of California, by W. P. Blake, Esq.—(See Coast Survey Report for 1855, page 389.)

From Point San José to *North Point*, at the base of *Telegraph Hill*, the distance is one mile, and the bearing E. ¾ N. All this space forms part of the city of San Francisco, and is covered with houses. The shore-line is denominated the *North Beach*, and from about the middle of the lowest part projects a long wharf over the flats to 3 fathoms water.

Telegraph Hill rises to a height of 289 feet, and is covered with houses to its summit wherever building room can be obtained. The present plan of the city grades contemplates the entire removal of this hill.

The geographical position of the triangulation station of the Coast Survey, upon its summit, is:

	°	′	″	
Latitude	37	48	06.4	north.
Longitude	122	23	19.4	west.
	h	*m.*	*s.*	
Or, in time	8	9	33.3	

ALCATRAZ ISLAND.

This is the first island that is opened in entering the Golden Gate, and upon it is erected a light-house. The island is nearly 600 yards long, in a W.NW. direction, by about 260 in width, and rises to an elevation of 135 feet above high water. The summit is flat, falling away gently on all sides for some distance, and then at the sides dropping perpendicularly. Upon the top exists a thin layer of earth, but the island is composed of a fine grained and "very compact sandstone of a dark bluish green color. It is regularly stratified in beds of varying thickness, and often separated by thin layers of argillaceous shale. It appears to contain a large amount of protoxide of iron, which changes to the hydrous sesquioxide on exposure." Deep water marks exist all round the island, and, with the exception of one or two places, the sides are so steep that a landing is effected with difficulty. Extensive fortifications are now in course of construction upon it. At the SE. side a small pier has been built to receive stores, ordnance, and materials. Off the NW. part foul bottom makes out about 300 or 400 yards.

Alcatraz Island Light-house is built on the summit of the island, and bears NW. from Telegraph Hill, distant 1⅝ mile; from Fort Point NE. ¾ E. distance 2⅝ miles.

The light is a *fixed harbor light of the natural color* and of the third order of Fresnel, illuminating the entire horizon, and exhibited from sunset to sunrise. It is 160 feet above the level of the sea, and should be seen from the sea, under ordinary states of the atmosphere, at a distance of 14 miles, or outside the bell-boat off the bar.

Its geographical position is:

	° ′ ″	
Latitude	37 49 33.0	north.
Longitude	122 24 18.8	west.
	h. m. s.	
Or, in time	8 9 37.3	

No hidden dangers have been discovered in the entrance outside of the line from Fort Point to Lime Point Bluff, but there are several inside.

Presidio Shoal, having $3\frac{1}{2}$ fathoms upon it, lies $1\frac{1}{8}$ mile inside of Fort Point, and bears NE. by E. $\frac{1}{4}$ E. from it, or three-quarters of a point eastward of the line between the lights on Fort Point and Alcatraz island. The shoal is about 700 yards long within the 4-fathom curve, and over half a mile long within the 5-fathom curve. It is very narrow, shows sandy bottom, and has deep water all round it. Its general direction is on the above mentioned bearing.

From the shoalest part the Presidio flag-staff bears S. $\frac{1}{2}$ E., and we have ventured to distinguish the shoal by that name.

Anita Rock shows above water at low tides and is situated $1\frac{1}{6}$ mile inside of Fort Point and bears E. by N. from it. It is only 300 yards from the low beach and has deep water close around it.

"A spar buoy, painted red, with even numbers, has been placed in 3 fathoms water, about half a cable's length due west from the shoalest part of Anita rock. Vessels should not approach this buoy within a cable's length, as a strong current sets across the rock." It was named after the United States Quartermaster's barque Anita, that struck upon it.

Bird Rock shows above water at low tides, with deep water close to it on every side. It bears W. $\frac{3}{4}$ S. from the light-house on Alcatraz island, and is distant seven-eighths of a mile.

Shag Rock is a low white topped rock, about half a mile nearly N.NE. from Bird rock. From Alcatraz light it bears W. by N., distant 1 mile. For about 300 yards towards Alcatraz island the bottom is foul and irregular, but outside that limit 10 fathoms are found. The rock shows about 4 feet above the highest tides, being then not more than 8 or 10 feet in extent.

Blossom Rock is a ledge having 5 feet water upon it at the lowest tides, and within the 3-fathom curve, is about 300 by 200 yards in extent, with deep water outside these limits. A spar buoy, painted with red and black horizontal stripes, has been placed in 4 fathoms water, about half a cable's length due south from the shoalest part of the ledge. Vessels should not approach this buoy from any direction nearer than a cable's length.

This ledge bears E. by S. from Alcatraz light, and $1\frac{1}{8}$ mile distant, being almost on the line joining the south points of Alcatraz and Yerba Buena islands. From the summit of Telegraph Hill it bears N. 6° W., distant 1 mile.

It was discovered and named by Beechy, after his ship, in November 1826.

Yerba Buena Island is the large high island opened to the east and south of Alcatraz after entering the Golden Gate. The western point of this island is $1\frac{3}{4}$ mile from Telegraph Hill, and the bearing NE. by E. Its peak is 343 feet high; the sides steep and irregular, and rising to a ridge running nearly east and west. On the western or San Francisco side the water is very deep close in shore, but from the NW. point a 3-fathom bank extends $1\frac{1}{4}$ mile NW. by N., spreading to the eastward for half a mile, and thence running to the NE. point. The wreck of the ship Crown Princess lies in 5 fathoms on the western edge of this band, and a day-mark, painted red, has been attached to her, consisting of a plank 7 inches by 3, 30 feet long, showing

15 feet above high water, with a board 5 feet long nailed across just below the top. The following bearings and distances give its position:

Alcatraz island light-house, W. by S., $2\frac{1}{4}$ miles.

Telegraph Hill, SW. by S., $1\frac{7}{8}$ mile.

West end of Yerba Buena island, SE. by S. $\frac{1}{8}$ S., $\frac{3}{4}$ mile.

East end of Yerba Buena island, E. by S. $\frac{1}{4}$ S., 1 mile.

Angel Island.—When passing through the narrowest part of the Golden Gate this large island bears about N.NE., and is seen as an island for a very short time when in the narrowest part of the Golden Gate. It has an irregular and bold shore-line of about 5 miles, and an area of one square mile. It rises to a height of 771 feet, is covered with grass and bushes, and cut in every direction by deep gulleys. As seen from the southeastward it appears part of the northern peninsula, but is divided from that in its NW. face by Raccoon straits, three quarters of a mile in width, having a depth of water ranging from 10 to 30 fathoms, and a very strong current. A narrow high jutting point makes out from the SE. portion of the island, bearing N. $\frac{3}{4}$ W. from Alcatraz island light, and distant $1\frac{5}{8}$ mile. From this head the general trend of the southern face for over a mile is W. by S. toward Saucelito Point.

Punta de los Cavallos is half a mile N.NW. from Lime Point bluff. The shore-line between them falls slightly back, and a very small valley makes down from the high hills behind.

Point Saucelito.—From Point Cavallos the general trend of the shore is NW. by N. for $1\frac{1}{2}$ mile to Point Saucelito with nearly a straight shore-line. One mile from Point Cavallos is the anchorage of Saucelito, where men-of-war and whalers formerly anchored. It lies abreast of a few houses forming the town of Saucelito, whence much of the water used in San Francisco is taken in steam water-boats. North of this anchorage is a large bay, with but a few feet water. From Saucelito Point to the western point of Angel island the distance is $1\frac{3}{4}$ mile, and the bearing NE. by E. $\frac{1}{2}$ E.

To Peninsula Point, forming the southwestern part of Raccoon strait, the distance is one mile, and bearing NE. $\frac{3}{8}$ E.

The following list of geographical positions in San Francisco bay is taken from the published reports of the United States Coast Survey:

"*Outer telegraph station,*" on the summit of the hill behind Point Lobos.

	°	′	″	
Latitude	37	46	56.6	north.
Longitude	122	29	23.3	west.
	h.	m.	s.	
Or, in time	8	09	57.5.	

"*Presidio*" near the Presidio of San Francisco. Primary astronomical station.

	°	′	″	
Latitude	37	47	36.1	north.
Longitude	122	26	15	west.
	h.	m.	s.	
Or, in time	8	09	45.0.	

Magnetic variation, 15° 27′ east in February, 1852; yearly increase, 1′.4.

Telegraph Hill, near the San Francisco observatory. Primary astronomical station.

	°	′	″	
Latitude	37	47	59.2	north.
Longitude	122	23	10	west.
	h.	m.	s.	
Or, in time	8	09	32.5.	

The highest part of the hill is 301 feet above high water.

Rincon, summit of the slight hill NE. of South Park. Secondary astronomical station.

	°	′	″	
Latitude	37	47	07.0	north.
Longitude	122	22	32	west.
	h.	*m.*	*s.*	
Or, in time	8	09	30.1.	

Tides.—As a general rule there is one large and one small tide during each day, the heights of two successive high waters occurring one, a. m., and the other, p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. These inequalities depend upon the moon's declination. They disappear near the time of the moon's declination being nothing, and are greatest about the time of its being greatest. The inequalities for low water are not the same as for high, though they disappear and have the greatest value at nearly the same times.

When the moon's declination is north, the highest of the two high tides of the twenty-four hours occurs at San Francisco about eleven and a half hours after the moon's transit; and when the declination is south, the lowest of the two high tides occurs at about that interval. The lowest of the two low waters of the day is the one which follows next the highest high water.

Tables I and II give the number to be added to the time of moon's transit to find the time of high water. It is one of double entry, the time of transit being placed in the first column, and the number of days from the day at which the moon had the greatest declination being arranged at the top of the table. Entering the first column with the time of transit, and following the line horizontally until we come under the column containing the days from the greatest declination, we find the number to be added to the time of transit to give the time of high water. If the moon's declination is south, Table I is to be used; if north, Table II.

TABLE I.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	11 49	12 7	12 25	12 43	12 57	13 12	13 20	13 16	13 10	13 2	12 51	12 38	12 21	0 0
0 30	11 43	12 1	12 19	12 37	12 51	13 6	13 14	13 10	13 4	12 56	12 45	12 32	12 15	0 30
1 0	11 37	11 55	12 13	12 31	12 45	13 0	13 8	13 4	12 58	12 50	12 39	12 26	12 9	1 0
1 30	11 31	11 49	12 7	12 25	12 39	12 54	13 2	12 58	12 52	12 44	12 33	12 20	12 3	1 30
2 0	11 25	11 43	12 1	12 19	12 33	12 48	12 56	12 52	12 46	12 38	12 27	12 14	11 57	2 0
2 30	11 20	11 38	11 56	12 14	12 28	12 43	12 51	12 47	12 41	12 33	12 22	12 9	11 52	2 30
3 0	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 6	11 49	3 0
3 30	11 17	11 35	11 53	12 11	12 25	12 40	12 48	12 44	12 38	12 30	12 19	12 6	11 49	3 30
4 0	11 22	11 40	11 58	12 16	12 30	12 45	12 53	12 49	12 43	12 35	12 24	12 11	11 54	4 0
4 30	11 30	11 48	12 6	12 24	12 38	12 53	13 1	13 57	12 51	12 43	12 32	12 19	12 2	4 30
5 0	11 39	11 57	12 15	12 33	12 47	13 2	13 10	13 6	13 0	12 52	12 41	12 28	12 11	5 0
5 30	11 47	12 5	12 23	12 41	12 55	13 10	13 18	13 14	13 8	13 0	12 49	12 36	12 19	5 30
6 0	11 55	12 13	12 31	12 49	13 3	13 18	13 26	13 22	13 16	13 8	12 57	12 44	12 27	6 0
6 30	12 0	12 18	12 36	12 54	13 8	13 23	13 31	13 27	13 21	13 13	13 2	12 49	12 32	6 30
7 0	12 7	12 25	12 43	13 1	13 15	13 30	13 38	13 34	13 28	13 20	13 9	12 56	12 39	7 0
7 30	12 13	12 31	12 49	13 7	13 21	13 36	13 44	13 40	13 34	13 26	13 15	13 2	12 45	7 30
8 0	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 7	12 50	8 0
8 30	12 21	12 39	12 57	13 15	13 29	13 44	13 52	13 48	13 42	13 34	13 23	13 10	12 53	8 30
9 0	12 20	12 38	12 56	13 14	13 28	13 43	13 51	13 47	13 41	13 33	13 22	13 9	12 52	9 0
9 30	12 18	12 36	12 54	13 12	13 26	13 41	13 49	13 45	13 39	13 31	13 20	13 7	12 50	9 30
10 0	12 14	12 32	12 50	13 8	13 22	13 37	13 45	13 41	13 35	13 27	13 16	13 3	12 46	10 0
10 30	12 8	12 26	12 44	13 2	13 16	13 31	13 39	13 35	13 29	13 21	13 10	12 57	12 40	10 30
11 0	12 1	12 19	12 37	12 55	13 9	13 24	13 32	13 28	13 22	13 14	13 3	12 50	12 33	11 0
11 30	11 53	12 11	12 29	12 47	13 1	13 16	13 24	13 20	13 14	13 6	12 55	12 42	12 25	11 30

TABLE II.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—						After—							
	6	5	4	3	2	1	0	1	2	3	4	5	6	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	12 21	12 3	11 45	11 27	11 13	10 58	10 50	10 54	11 0	11 8	11 19	11 32	11 49	0 0
0 30	12 15	11 57	11 39	11 21	11 7	10 52	10 44	10 48	10 54	11 2	11 13	11 26	11 43	0 30
1 0	12 9	11 51	11 33	11 15	11 1	10 46	10 38	10 42	10 48	10 56	11 7	11 20	11 37	1 0
1 30	12 3	11 45	11 27	11 9	10 55	10 40	10 32	10 36	10 42	10 50	11 1	11 14	11 31	1 30
2 0	11 57	11 39	11 21	11 3	10 49	10 34	10 26	10 30	10 36	10 44	10 55	11 8	11 25	2 0
2 30	11 52	11 34	11 16	10 58	10 44	10 29	10 21	10 25	10 31	10 39	10 50	11 3	11 20	2 30
3 0	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 0	11 17	3 0
3 30	11 49	11 31	11 13	10 55	10 41	10 26	10 18	10 22	10 28	10 36	10 47	11 0	11 17	3 30
4 0	11 54	11 36	11 18	11 0	10 46	10 31	10 23	10 27	10 33	10 41	10 52	11 5	11 22	4 0
4 30	12 2	11 44	11 26	11 8	10 54	10 39	10 31	10 35	10 41	10 49	11 0	11 13	11 30	4 30
5 0	12 11	11 53	11 35	11 17	11 3	10 48	10 40	10 44	10 50	10 58	11 9	11 22	11 39	5 0
5 30	12 19	12 1	11 43	11 25	11 11	10 56	10 48	10 52	10 58	11 6	11 17	11 30	11 47	5 30
6 0	12 27	12 9	11 51	11 33	11 19	11 4	10 56	11 0	11 6	11 14	11 25	11 38	11 55	6 0
6 30	12 32	12 14	11 56	11 38	11 24	11 9	11 1	11 5	11 11	11 19	11 30	11 43	12 0	6 30
7 0	12 39	12 21	12 3	11 45	11 31	11 16	11 8	11 12	11 18	11 26	11 37	11 50	12 7	7 0
7 30	12 45	12 27	12 9	11 51	11 37	11 22	11 14	11 18	11 24	11 32	11 43	11 56	12 13	7 30
8 0	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 1	12 18	8 0
8 30	12 53	12 35	12 17	11 59	11 45	11 30	11 22	11 26	11 32	11 40	11 51	12 4	12 21	8 30
9 0	12 52	12 34	12 16	11 58	11 44	11 29	11 21	11 25	11 31	11 39	11 50	12 3	12 20	9 30
9 30	12 50	12 32	12 14	11 56	11 42	11 27	11 19	11 23	11 29	11 37	11 48	12 1	12 18	9 0
10 0	12 46	12 28	12 10	11 52	11 38	11 23	11 15	11 19	11 25	11 33	11 44	11 57	12 14	10 0
10 30	12 40	12 22	12 4	11 46	11 32	11 17	11 9	11 13	11 19	11 27	11 38	11 51	12 8	10 30
11 0	12 33	12 15	11 57	11 39	11 25	11 10	11 2	11 6	11 12	11 20	11 31	11 44	12 1	11 0
11 30	12 25	12 7	11 49	11 31	11 17	11 2	10 54	10 58	11 4	11 12	11 23	11 36	11 58	11 30

Example.—Required the time of high water at North Beach, San Francisco, on the 7th of February, 1853.

1st. The time of the moon's transit at Greenwich, from the British Nautical Almanac, is 11*h.* 41*m.*; the longitude of San Francisco, 8*h.* 10*m.*; requiring a correction of 16*m.* to the time of transit at San Francisco, which is thus found to be 11*h.* 57*m.*

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table I, we find 12*h.* (or 0*h.*) of transit, the nearest number to 11*h.* 57*m.* which the table gives; and following the line horizontally until we come to two days after the greatest declination we find 13*h.* 10*m.*

To 11*h.* 57*m.* time of transit of moon, February 7, San Francisco,
Add 13 10 from column 0*h.* transit, and two days after greatest declination.

The sum 25 7 or 1*h.* 7*m.*, February 8, is the time of high water corresponding to the transit which we took of February 7. If we desire the tide of February 7, we must go back to the moon's transit of the 6th. The example was purposely assumed to show this case.

To 11*h.* 1*m.*, time of transit, February 6, 1853,
Add 13 28 number for 11*h.* transit, and one day from greatest declination.

Sum 24 29, time of high water, 0*h.* 29*m.*, a. m., February 7.

The height of high water is obtained in a similar manner by the use of Table III and IV, entering these in the same way with the time of transit and days from the greatest declination. Table III is for south declination, and Table IV for north.

TABLE III.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.2	4.0	3.8	3.7	3.7	3.6	3.7	3.9	4.0	4.1	4.3	4.6	4.8	0
1	3.6	3.4	3.2	3.1	3.1	3.0	3.1	3.3	3.4	3.5	3.7	4.0	4.2	1
2	3.4	3.2	3.0	2.9	2.9	2.8	2.9	3.1	3.2	3.3	3.5	3.8	4.0	2
3	3.2	3.0	2.8	2.7	2.7	2.6	2.7	2.9	3.0	3.1	3.3	2.6	3.8	3
4	2.8	2.6	2.4	2.3	2.3	2.2	2.3	2.5	2.6	2.7	2.9	3.2	3.4	4
5	2.5	2.3	2.1	2.0	2.0	1.9	2.0	2.2	2.3	2.4	2.6	2.9	3.1	5
6	2.4	2.2	2.0	1.9	1.9	1.8	1.9	2.1	2.2	2.3	2.5	2.8	3.0	6
7	2.7	2.5	2.3	2.2	2.2	2.1	2.2	2.4	2.5	2.6	2.8	3.1	3.3	7
8	3.1	2.9	2.7	2.6	2.6	2.5	2.6	2.8	2.9	3.0	3.2	3.5	3.7	8
9	3.5	3.3	3.1	3 0	3.0	2.9	3.0	3.2	3.3	3.4	3.6	3.9	4.1	9
10	3.7	3.5	3.3	3.2	3.2	3.1	3.2	3.4	3.5	3.6	3.8	4.1	4.3	10
11	3.9	3.7	3.5	3.4	3.4	3.3	3.4	3.6	3.7	3.8	4.0	4.3	4.5	11

TABLE IV.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.													Time of moon's transit.
	Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.8	5.0	5.2	5.3	5.3	5.4	5.3	5.1	5.0	4.9	4.7	4.4	4.2	0
1	4.2	4.4	4.6	4.7	4.7	4.8	4.7	4.5	4.4	4.3	4.1	3.8	3.6	1
2	4.0	4.2	4.4	4.5	4.5	4.6	4.5	4.3	4.2	4.1	3.9	3.6	3.4	2
3	3.8	4.0	4.2	4.3	4.3	4.4	4.3	4.1	4.0	3.9	3.7	3.4	3.2	3
4	3.4	3.6	3.8	3.9	3.9	4.0	3.9	3.7	3.6	3.5	3.3	3.0	2.8	4
5	3.1	3.3	3.5	3.6	3.6	3.7	3.6	3.4	3.3	3.2	3.0	2.7	2.5	5
6	3.0	3.2	3.4	3.5	3.5	3.6	3.5	3.3	3.2	3.1	2.9	2.6	2.4	6
7	3.3	3.5	3.7	3.8	3.8	3.9	3.8	3.6	3.5	3.4	3.2	2.9	2.7	7
8	3.7	3.9	4.1	4.2	4.2	4.3	4.2	4.0	3.9	3.8	3.6	3.3	3.1	8
9	4.1	4.3	4.5	4.6	4.6	4.7	4.6	4.4	4.3	4.2	4.0	3.7	3.5	9
10	4.3	4.5	4.7	4.8	4.8	4.9	4.8	4.6	4.5	4.4	4.2	3.9	3.7	10
11	4.5	4.7	4.9	5.0	5.0	5.1	5.0	4.8	4.7	4.6	4.4	4.1	3.9	11

Example.—To obtain the height of the tide on February 7, 1853, the declination being south, we enter Table III, with 0*h.* of transit, and two days after greatest declination, and find that the tide will be 4.0 feet above the mean of the lowest low waters, or that 4.0 feet are to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the soundings of the chart were given for mean low water, then 1.2 feet ought to be subtracted from the Tables III and IV; thus, in this example, it would be 2.8 feet.

The approximate times of the successive low and high waters of the day will be found by adding the numbers in Table V to the time of the first high water already determined. The table gives the numbers for the different days from the greatest declination.

TABLE V.—*Containing numbers to be added to the time of high water found from tables* I *and* II, *to obtain the successive low and high waters.*

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*		
Before.	6	5 48	13 0	18 54	5 54	11 57	17 45	6	Before.
	5	5 25	12 28	18 45	6 17	12 32	17 57	5	
	4	5 3	11 50	18 29	6 39	13 10	18 13	4	
	3	4 45	11 16	18 13	6 57	13 44	18 29	3	
	2	4 30	10 46	17 58	7 12	14 14	18 44	2	
	1	4 18	10 18	17 42	7 24	14 42	19 0	1	
	0	4 12	10 0	17 30	7 30	15 0	19 12	0	
After.	1	4 24	10 10	17 28	7 18	14 50	19 14	1	After.
	2	4 34	10 20	17 28	7 8	14 40	19 14	2	
	3	4 49	10 36	17 29	6 53	14 24	19 13	3	
	4	5 6	10 58	17 34	6 36	14 2	19 8	4	
	5	5 24	11 24	17 42	6 18	13 36	19 0	5	
	6	5 51	11 53	17 45	6 52	13 8	18 59	6	

The days from greatest declination are written in the first and last columns of the table. The second, third, and fourth columns refer to south declination, and the fifth, sixth, and seventh to north. The second column gives the number which is to be added according to the declination to the time of high water obtained by means of Tables I and II to give the next low water, which is a small low water. The third contains the numbers to be added to the same to give the second or large high water. The fourth, the numbers to be added to the same to give the second or large low water. The succeeding columns give the numbers to be used in the same way for north declinations, to obtain the large low water, the small high water, and the small low water.

The rise and fall of the same successive tides may be obtained by inspection from Table VI, in which the first column, at the side, contains the time of transit, and the successive columns the numbers corresponding to that time, and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide are first given; then those for the rise from the small low water to the large high water; next the large ebb tide; and, lastly, the rise from the large low water to the small high water.

TABLE VI.—*Showing the rise and fall of the several tides corresponding to different hours of transit, and days from the greatest declination of the moon, at San Francisco, California.*

Hour of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.													FROM LARGE LOW WATER TO SMALL HIGH WATER.													Hour of moon's transit.
	Days from moon's greatest declination.													Days from moon's greatest declination.													
	Before—							After—						Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	6	5	4	3	2	1	0	1	2	3	4	5	6	
	Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	
0	4.6	4.0	3.3	2.8	2.4	2.0	1.9	2.0	2.3	2.6	3.0	3.7	4.3	5.2	5.0	4.7	4.4	4.0	3.8	3.5	3.2	3.3	3.4	3.4	3.5	3.7	0
1	4.0	3.4	2.7	2.2	1.8	1.4	1.3	1.4	1.7	2.0	2.4	3.1	3.7	4.6	4.4	4.1	3.8	3.4	3.2	2.9	2.6	2.7	2.8	2.8	2.9	3.1	1
2	3.8	3.2	2.5	2.0	1.6	1.2	1.1	1.2	1.5	1.8	2.2	2.9	3.5	4.4	4.2	3.9	3.6	3.2	3.0	2.7	2.4	2.5	2.6	2.6	2.7	2.9	2
3	3.6	3.0	2.3	1.8	1.4	1.0	0.9	1.0	1.3	1.6	2.0	2.7	3.3	4.2	4.0	3.7	3.4	3.0	2.8	2.5	2.2	2.3	2.4	2.4	2.5	2.7	3
4	3.2	2.6	1.9	1.4	1.0	0.6	0.5	0.6	0.9	1.2	1.6	2.3	2.9	3.8	3.6	3.3	3.0	2.6	2.4	2.1	1.8	1.9	2.0	2.0	2.1	2.3	4
5	2.9	2.3	1.6	1.1	0.7	0.3	0.2	0.3	0.6	0.9	1.3	2.0	2.6	3.5	3.3	3.0	2.7	2.3	2.1	1.8	1.5	1.6	1.7	1.7	1.8	2.0	5
6	2.8	2.2	1.5	1.0	0.6	0.2	0.1	0.2	0.5	0.8	1.2	1.9	2.5	3.4	3.2	2.9	2.6	2.2	2.0	1.7	1.4	1.5	1.6	1.6	1.7	1.9	6
7	3.1	2.5	1.8	1.3	0.9	0.5	0.4	0.5	0.8	1.1	1.5	2.2	2.8	3.7	3.5	3.2	2.9	2.5	2.3	2.0	1.7	1.8	1.9	1.9	2.0	2.2	7
8	3.5	2.9	2.2	1.7	1.3	0.9	0.8	0.9	1.2	1.5	1.9	2.6	3.2	4.1	3.9	3.6	3.3	2.9	2.7	2.4	2.1	2.2	2.3	2.3	2.4	2.6	8
9	3.9	3.3	2.6	2.1	1.7	1.3	1.2	1.3	1.6	1.9	2.3	3.0	3.6	4.5	4.3	4.0	3.7	3.3	3.1	2.8	2.5	2.6	2.7	2.7	2.8	3.0	9
10	4.1	3.5	2.8	2.3	1.9	1.5	1.4	1.5	1.8	2.1	3.5	3.2	3.8	4.7	4.5	4.2	3.9	3.5	3.3	3.0	2.7	2.8	2.9	2.9	3.0	3.2	10
11	4.3	3.7	3.0	2.5	2.1	1.7	1.6	1.7	2.0	2.3	2.7	3.4	4.0	4.9	4.7	4.4	4.1	3.7	3.5	3.2	2.9	3.0	3.1	3.1	3.2	3.4	11

TABLE VI.—Continued.

Hour of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.													FROM LARGE LOW WATER TO SMALL HIGH WATER.													Hour of moon's transit.
	Days from moon's greatest declination.													Days from moon's greatest declination.													
	Before—							After—						Before—							After—						
	6	5	4	3	2	1	0	1	2	3	4	5	6	6	5	4	3	2	1	0	1	2	3	4	5	6	
	Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft*	*Ft.*	*Ft*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
0	4.4	5.0	5.7	6.2	6.6	7.0	7.1	7.0	6.7	6.4	6.0	5.3	4.7	3.8	4.0	4.3	4.6	5.0	5.2	5.5	5.8	5.7	5.6	5.6	5.5	5.3	0
1	3.8	4.4	5.1	5.6	6.0	6.4	6.5	6.4	6.1	5.8	5.4	4.7	4.1	3.2	3.4	3.7	4.0	4.4	4.6	4.9	5.2	5.1	5.0	5.0	4.9	4.7	1
2	3.6	4.2	4.9	5.4	5.8	6.2	6.3	6.2	5.9	5.6	5.2	4.5	3.9	3.0	3.2	3.5	3.8	4.2	4.4	4.7	5.0	4.9	4.8	4.8	4.7	4.5	2
3	3.4	4.0	4.7	5.2	5.6	6.0	6.1	6.0	5.7	5.4	5.0	4.3	3.7	2.8	3.0	3.3	3.6	4.0	4.2	4.5	4.8	4.7	4.6	4.6	4.5	4.3	3
4	3.0	3.6	4.3	4.8	5.2	5.6	5.7	5.6	5.3	5.0	4.6	3.9	3.3	2.4	2.6	2.9	3.2	3.6	3.8	4.1	4.4	4.3	4.2	4.2	4.1	3.9	4
5	2.7	3.3	4.0	4.5	4.9	5.3	5.4	5.3	5.0	4.7	4.3	3.6	3.0	2.1	2.3	2.6	2.9	3.3	3.5	3.8	4.1	4.0	3.9	3.9	3.8	3.6	5
6	2.6	3.2	3.9	4.4	4.8	5.2	5.3	5.2	4.9	4.6	4.2	3.5	2.9	2.0	2.2	2.5	2.8	3.2	3.4	3.7	4.0	3.9	3.8	3.8	3.7	3.5	6
7	2.9	3.5	4.2	4.7	5.1	5.5	5.6	5.5	5.2	4.9	4.5	3.8	3.2	2.3	2.5	2.8	3.1	3.5	3.7	4.0	4.3	4.2	4.1	4.1	4.0	3.8	7
8	3.3	3.9	4.6	5.1	5.5	5.9	6.0	5.9	5.6	5.3	4.9	4.2	3.6	2.7	2.9	3.2	3.5	3.9	4.1	4.4	4.7	4.6	4.5	4.5	4.4	4.2	8
9	3.7	4.3	5.0	5.5	5.9	6.3	6.4	6.3	6.0	5.7	5.3	4.6	4.0	3.1	3.3	3.6	3.9	4.3	4.5	4.8	5.1	5.0	4.9	4.9	4.8	4.6	9
10	3.9	4.5	5.2	5.7	6.1	6.5	6.6	6.5	6.2	5.9	5.5	4.8	4.2	3.3	3.5	3.8	4.1	4.5	4.7	5.0	5.3	5.2	5.1	5.1	5.0	4.8	10
11	4.1	4.7	5.4	5.9	6.3	6.7	6.8	6.7	6.4	6.1	5.7	5.0	4.4	3.5	3.7	4.0	4.3	4.7	4.9	5.2	5.5	5.4	5.3	5.3	5.2	5.0	11

Example.—Thus, in the preceding example the high water of February 7 was found to be 2.8 feet above mean low water. The declination being south, this high water is the small one. To obtain the fall of the next low water or small low water, we enter table VI, with 0*h.* of moon's transit and two days after greatest declination, in the first part of the table and find 2.3 feet, which will be the difference in height of this high and low water. Entering with the same transit and day in the second part, we find 3.3 feet, which is the rise of the large high water above the small low water; the difference between 2.3 feet and 3.3 feet or 1.0 foot is the difference of height of the two successive high waters. It is easy to see how, in this way, the soundings of a chart can be reduced to what they would be approximately at all the successive high and low waters.

Sailing directions.—In approaching the coast every opportunity should be seized for determining the vessel's position, as fogs and thick weather prevail near the land. Vessels coming from the *southward* make the coast about Point Año Nuevo, (lat. 37° 07′ N.,) and follow it at a distance of 4 or 5 miles up to the bar. Coming from the *northward* they make Punta de los Reyes, in latitude 38° 00′ N., and run E. SE. to the bell-boat, 22 miles. Coming from the *westward* they first sight the South Farallone island, (latitude 37° 42′ N.,) having the light-house upon it, and keep upon either side of it; but it is preferable to go to the southward, as the vicinity of the island has not yet been surveyed in detail. From the South Farallone light-house the Point Boneta light bears NE. by E., 23⅝ miles; and the bell-boat outside the bar bears NE. by E. ½ E., 16½ miles. Coming from the *northwestward* they pass within 2 or 3 miles of Punta de los Reyes; 15 fathoms being found within a quarter of a mile from it, but vessels are apt to lose the wind by getting too close under it. From the western extremity of this point the Point Boneta light bears E. ¾ S., distant 25¾ miles, the line passing over the tail of Duxbury reef, at a distance of 17¼ miles from Los Reyes. To the bell-boat off the bar the bearing is SE. by E. ⅝ E., and distance 22¼ miles.

The bell-boat, 1½ mile outside of the bar, is placed on the prolongation of the range from Alcatraz island to Fort Point, giving a course NE. ¾ E. for vessels entering the Golden Gate, and designated by Belcher the "fair way line," and he calls the island and fort the "fair way marks." But with a heavy swell on the bar this range should be used merely as a line of reference, because on the bar it passes over a small 5-fathom spot, while half a fathom more can be obtained for a distance of two miles both north and south of it. In clear weather and with a favorable wind a vessel can cross the bar in not less than 5 fathoms from the line, having the north end of Alcatraz island just open by Point Boneta (NE. by E. ¾ E.) round to the shore south of Point Lobos, (N. by W. ⅓ W.) Northward of the former line the four-fathom bank (having 3¾ fathoms on it) commences one mile west of Boneta, and stretches out over 3 miles, with a breadth of one mile. Upon this bank the clipper Golden Fleece struck in 1857, and came into port with 7 or 8 feet of water in her hold. She was the second of her name that was unfortunate in entering the harbor, the first having been totally lost on Fort Point. Inside of this four-fathom bank the deepest water can be got for entering, but it would be dangerous for a sailing vessel to attempt it with a flood tide and light winds. While it is breaking on the bank only a heavy swell is found through this 8½-fathom channel, and small sailboats have passed in safety when they dared not try the bar. During clear, moderate weather any vessel can cross the bar within the limits we have mentioned, without running until she has got on the "fair way line," whereby she might lose her slant of wind. Should the wind fail, or be light, and the current adverse, anchor outside the bar in 15 fathoms, mud and fine sand; or, after crossing the bar, in 6 to 10 fathoms, fine gray sand, with red specks in some places. Run in mid-channel between the heads, and between Fort Point and the opposite shore, taking special care not to approach Fort Point too close, because the currents set around it irregularly and with great rapidity, and the bottom is uneven and rocky. A depth of 69 fathoms is given in the centre of the channel. In the Golden Gate we have measured an ebb current running above 6 miles per hour. As a general rule, the winds increase within the heads, drawing in very strongly abreast of Fort Point. When off this point steer for Alcatraz light-house until the north point of Telegraph Hill bears E. by S., then steer to give it a berth of a quarter of a mile, running through among the shipping.

In making the port at night it is customary to run for the bell-boat, and cross the bar with Fort Point light on with Alcatraz island light, or, better, the latter a little open to the northward. But this practice frequently involves much delay and annoyance when the wind will not permit a vessel to attain this position without a tack. With Boneta light bearing from N. by W. to NE. by E., a vessel may boldly run on within those limits, and unless there is a heavy swell safely cross the four-fathom bank. Give Boneta a berth of a mile, and when within the heads, and Boneta abeam, gradually open Alcatraz light north of Fort Point, until abeam of the latter; then run for Alcatraz until the lights of the shipping show the vessel's position. Hauling up for them, anchor off the north beach in 10 fathoms, or off the northeast front of the city in 10 fathoms, soft mud.

In coming upon the coast in thick foggy weather, sailing vessels should not run into less than 50 fathoms, because the water around the South Farallone and off Point San Pedro and Punta de los Reyes is very bold. It is believed, however, that a 30-fathom bank exists at a considerable distance to the westward of the last. If the Farallones are made, a course can be easily laid for the bar, but it would be unadvisable to run into less than 20 fathoms, soft mud, if the bell-boat be not heard, as the set and strength of the currents off the entrance to the bay are yet undetermined. Belcher says that, being caught in a fog, he anchored in 15 fathoms, to the southward of the bar, and determined "that southerly of the fair way line the ebb tide set N.NE., flood S.SW." We suppose he means *from* the N.NE., and from the S.SW. During the

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Mean monthly rain for	July,	.00	inches
" " "	August,	.00	"
" " "	September,	.18	"
" " "	October,	.45	"
" " "	November,	2.08	"
" " "	December,	4.45	"

Giving a yearly average of···· 21.17 inches.

These figures show clearly what months constitute each of these two characteristic seasons. To follow the case a little further, we find that for seven years, from 1850 to 1856, an average of 0.5 inch of rain fell during October; 2.1 inches in November; 1.2 inch during the first half of December, and 3.2 inches during the latter half of the month; 2.3 inches during the first half of January, and 1.2 during the last half; 0.8 inch during the first half of February, and 2.3 inches during the last half; 1.8 inch during the first half of March, and 1.6 inch during the last half; 1.5 inch during the first half of April, and 1.2 inch during the second; and about 0.7 inch in May.

The monthly means show that December is the rainiest month, and the last statement, that during the last half of December and the first half of January more than one-fourth of the average falls. There is a very notable abatement from the middle of January to the middle of February. In 1851 we noticed this particularly when stationed at Point Pinos, because the above period was much prolonged. Again, in 1852, while observing near the Presidio of San Francisco, we found this period to extend from the early part of January to near the end of February. During the latter part of March heavy rains occur, and about the middle of April. The southerly winds generally bring the rain. During the seasons we passed about San Francisco, we never heard thunder or saw lightning; and never but once saw snow fall, and then only at an elevation of 400 feet; the line being distinctly marked, and the elevation being well determined by a knowledge of the height of the hills.

The following statement will give a general idea of the temperature of the sea-board. The interior is much warmer, but on account of the dryness of the atmosphere the effect is not so enervating to the system as a lower temperature on the Atlantic.

Mean temperature at sunrise and noon for 6 years from 1851 to 1856, computed from the California State register for 1857:

	Sunrise.	Noon.
	Deg. Fahr.	*Deg. Fahr.*
January	44.0	57.7
February	46.9	60.5
March	47.6	63.1
April	49.3	65.6
May	49.9	64.5
June	51.4	68.1
July	52.6	67.8
August	53.7	68.2
September	54.0	69.9
October	52.7	68.4
November	49.8	61.9
December	45.2	55.7
Average	49.7	54.3

The lowest temperature experienced at San Francisco in the above 6 years was 25° Fah., in January, 1854. In 1852, '53, '56, the temperature was always above freezing; falling no lower than 40° in 1853.

The highest temperature was 98°, in September, 1852, and that may be considered remarkably high; 90° having been reached but once.

Statistics.—Previous to the discovery of gold in California, San Francisco bay furnished few inducements for traders or whalers to visit. Cattle were cheap, but about the only provisions to be obtained, and these were valuable solely for their hide and tallow; "fine fat bullocks, weighing from 400 to 500 pounds, hide included, were purchased at $5 each, and sheep at $2."—(Belcher, Vol. 1, page 135.) "All the forts were in ruins and not even a single gun mounted" at the time of his visit in 1837, and Wilkes' description of the few miserable *adobe* buildings at Yerba Buena, the site of San Francisco, fully proves how fast the country was driving to wreck. In 1848 the resources, the population, and geography of the State were almost unknown; but since then she has commanded the attention of the world. She stands alone as an example of all past time of a country emerging so suddenly from obscurity, and at one gigantic stride assuming the importance and complicated relations of a large empire. In less than ten years she has acquired a population of over half a million, and has developed the wonderful resources comprised within her limited boundaries. On the site of half a dozen adobe buildings has risen a city of 75,000 inhabitants, in whose streets are seen the dress and heard the tongue of every nation. Over 600 ships, under every known flag, have been anchored at one time in the harbor of San Francisco. The commercial enterprise developed has given birth to a new era of naval architecture; the old fashioned full, clumsy bowed ships, that carried the early adventurers round Cape Horn, and made their passages in something less than a year, have played out their part, and have been succeeded by the famed clippers. At the close of 1857 less than ten of the old hulks disfigured the harbor.

In the first three quarters of 1849 no less than 509 large vessels entered the bay; at the end of August of that year there were 62,000 tons of shipping at anchor, exclusive of vessels running on the Sacramento, San Joachim, the adjacent bays and in the coasting trade. On the 24th of September over 11,000 tons of shipping entered the Golden Gate, and at the end of September, there were 94,500 tons in the harbor. For a city one year old, and 17,500 miles from the nearest eastern ports, this may well be viewed as marvellous.

Clipper passages.—The number of clippers arriving at San Francisco from New York during the 8 years 1850 to 1857, was 503, and the average length of the passage was 133 days. In the same years 296 arrived from Boston, and the average passage was 134 days.

In 1850 six clippers arrived from New York averaging only 115 days; the Sea Witch being reported at 97 days, but her actual passage was 101. The average passage of all American vessels that arrived from Atlantic ports was 187 days.

In 1851 only two clippers made the passage in less than 100 days—the Surprise in 96, and the Flying Cloud in 90, both from New York.

In 1852 the Flying Fish made it in 98 days from Boston, and the Sword Fish in 93 from New York.

In 1853 it was made by the Contest in 97 days, Flying Fish in 92, John Gilpin in 93, and the Oriental reported 100; all from New York.

In 1854 the passage was made by the David Brown in 98 days, the Flying Cloud in 89, the Hurricane in 99, the Witchcraft in 97 from New York; and by the Romance of the Seas in 96 from Boston.

In 1855 no vessel made it in 100 days, although the Herald of the Morning reported in 100, and Neptune's Car in 100 from New York, and the Westward Ho in 100 from Boston.

In 1856 the Antelope made it in 97 days, and the Sweepstakes in 94 from New York.

In 1857 the Flying Dragon arrived in 98 days, and the Great Republic in 92 from New York. The Danish clipper Cimber made the trip from Liverpool in 106 days, the quickest on record.

The shortest passage made from New York to San Francisco by steamship, via the Isthmus, was by the Moses Taylor on the eastern side, and the Golden Age on the western; their actual running time 19 days 23 hours; total time from dock to wharf 21 days, 2 hours, 13 minutes, arriving at San Francisco February 26, 1858.

The Northern Light, of Boston, is reported to have made the run from San Francisco to New York, in ballast, in 75¼ days, and the Trade Wind, with cargo, in 84 days.

The year 1857 will very well represent the average length of passages from other ports, and is herewith introduced.

From China 32 vessels arrived, averaging 59 days; the quickest trip from Shanghai being 34 days, by the Fern Spray, and from Hong Kong in 35 days, by the schooner Giulietta.

From Honolulu 19 vessels arrived, averaging 19½ days; the shortest trip being made by the barque Yankee, in 13 days.

From Valparaiso 17 vessels arrived, averaging 53 days; the shortest passage being made by the Danish ship Velox, in 37 days.

From Australia 13 vessels arrived, averaging 81½ days; the shortest passage by the topsail schooner Vaquero, in 67 days.

Tonnage of San Francisco.—At the end of the fiscal year, June 30, 1855, there were registered, enrolled, and licensed, at the custom-house of San Francisco, owned wholly or in part by citizens of California, 702 steam and sailing vessels engaged in trade upon the Pacific, distributed under the following heads:

Registered tonnage.

3 steamships	1,058 tons.	
36 ships	14,428 tons.	
59 barques	15,999 tons.	
50 brigs	8,592 tons.	
49 schooners	5,887 tons.	
Total		45,964

Enrolled tonnage.

45 steamships	11,223 tons.	
1 ship	386 tons.	
17 barques	3,759 tons.	
28 brigs	4,667 tons.	
127 schooners	8,774 tons.	
59 sloops	2,137 tons.	
Total		30,946
In addition to the above, there were licensed at that time, as coasters, 228 schooners and sloops below 20 tons each, with an aggregate tonnage of		2,399
Making a total of permanent registered, enrolled, and licensed tonnage of 702 vessels of		79,309

We have no means now at hand for ascertaining the increase up to 1857, but the following tables, exhibiting the tonnage entering and clearing the port of San Francisco, may not be without interest:

Tonnage of the port of San Francisco.

Years.	ARRIVALS.		DEPARTURES.	
	American vessels from American & foreign ports.	Foreign vessels from foreign ports.	American vessels to American & foreign ports.	Foreign vessels to foreign ports.
	Tons.	*Tons.*	*Tons.*	*Tons.*
1849	108,644	65,729	Books of custom-	house destroyed by
1850	255,428	131,628	fire.	
1851	292,940	125,965		
1852	268,737	132,094	344,760	131,111
1853	404,220	124,874	501,229	137,110
1854	336,058	76,127	426,775	83,871
1855	325,102	55,148	369,213	48,322
1856	305,519	40,378	347,451	41,809
1857	382,958	44,608	291,879	45,143

A great number of vessels that arrived in 1849, '50, '51, began to clear in 1852, when seamen could be obtained.

The following shows in more detail the shipping operations of the year 1857:

Table showing the shipping entered and cleared at the port of San Francisco for the year 1857.

	Entered.	Tons.
No. of American vessels from American ports	1,328	291,561
No. of American vessels from foreign ports	130	91,397
No. of foreign vessels from foreign ports	125	44,608
	1,583	427,566
	Cleared.	Tons.
No. of American vessels for American ports	516	108,538
No. of American vessels for foreign ports	203	183,341
No. of foreign vessels for foreign ports	129	45,143
	848	337,022

The difference noticeable between the vessels entered from and cleared for American ports is owing to the fact that these vessels are not required to clear at the custom-house, and therefore many departures are not noticed.

Table showing the total tonnage entered from eastern States and from foreign ports, with the amount of freights paid upon the cargoes.

Years.	Tons.	Freight.
1853	407,235	$11,752,084
1854	254,714	5,311,612
1855	247,682	3,999,755
1856	236,389	4,592,104
1857	197,814	2,842,671

The steamship tonnage entered from Panama and San Juan del Sud, and the coasting tonnage entered, were as follows:

Years.	Steamship.	Coasting.
	Tons.	*Tons.*
1853	83,432	67,213
1854	85,735	59,230
1855	77,280	146,495
1856	65,477	138,149
1857	47,716	182,036

During the years 1856, 1857, the movements of the fillibusters retarded, and finally put a stop to all travel across the isthmus of Nicaragua, and the steamships were hauled off.

Table of the value of imports, free and otherwise, into the district of San Francisco.

1854	$5,899,620
1855	7,144,075
1856	9,155,507
1857	6,397,354

Table showing the value of imports of certain articles, such as flour, grain, salt meats, &c., now produced in California.

1853	$14,021,940
1854	5,161,586
1855	2,444,626
1856	1,248,343
1857	1,631,467

Table showing the receipts of customs at the port of San Francisco, and the expenditures.

Year.	Receipts.	Expenditures.
1848, 1849	$1,581,640	
1850	1,908,220	$303,033
1851	2,316,675	1,009,436
1852	2,008,410	655,694
1853	2,589,406	684,114
1854	1,563,103	646,288
1855	1,804,904	438,684
1856	1,713,408	441,678
1857	Nearly 1,550,000	

Value of the exports of California produce from San Francisco.

1855	$4,877,519
1856	4,157,265
1857	4,493,845

Of these amounts the following are the principal items:

Year.	Wheat, oats, barley.	Flour.	Quicksilver.
1854	$50,538	$68,861	$648,317
1855	224,993	815,960	975,621
1856	91,016	765,212	833,185
1857			954,100

Table showing the passengers arrived by steamship and sailing vessels at the port of San Francisco.

Year.	Arrived.	Departed.
1849	91,405	
1850	36,462	
1851	27,182	
1852	66,988	22,946
1853	33,233	30,001
1854	47,531	23,508
1855	29,198	22,898
1856	28,119	22,747
1857	24,759	16,906

The following table will exhibit the tonnage movement of the principal cities of the United States for the year 1856:

City.	Entered.	Cleared.	Total.
New York	1,681,659	1,520,623	3,202,282
Boston	682,165	647,404	1,329,569
New Orleans	663,067	773,162	1,436,229
San Francisco	345,897	389,260	735,157
Philadelphia	173,179	129,739	302,918

It would be doing injustice to the State not to give a few facts relating to her principal mineral wealth.

The average amount of gold taken from the country during the last seven years has been fully $55,000,000 per annum; the average value of the exported cotton crop of the United States for the same period was $100,000,000; and of the breadstuffs and provisions $55,500,000.

The following table exhibits the amount of gold shipped, per manifest, from San Francisco from 1849 to 1857:

1849	$4,921,250
1850	27,676,346
1851	42,582,695
1852	46,586,134
1853	57,331,024
1854	51,328,653
1855	43,080,211
1856	48,887,543
1857	48,976,207

To the end of 1856 there was coined at the United States mint and branches $360,744,914 of California gold, but the amount manifested was only $322,393,856 for the same period.

This shows that $38,351,058 had been carried to the United States mint by private hands, and, allowing that a large amount had likewise been carried to foreign countries, we may safely assume that five and a half millions are annually carried out of the State by persons leaving it. Of the amount retained in the State for circulation we can form no fair estimate.

The gold coinage of the branch mint at San Francisco has been as follows:

Year.	Coin.	Bars.	Total.
1854	$4,084,207	$5,631,151	$9,715,358
1855	16,498,300	3,359,377	19,857,677
1856	25,146,700	3,547,001	28,693,701
1857*			20,407,000

* Suspended operations about five months.

The following figures will exhibit the marked influence which the gold product of California has had upon the coinage of the United States. Previous to 1850 the total coinage of the Mint, including the coinage of the branch mints, from the commencement of their operations, was $85,349,201; silver coinage, $30,344,808. From 1850 there has been coined of gold, $370,889,738, and of silver $75,581,465. The total coinage of gold, silver, and copper for the above respective periods was $150,017,714, in 57 years; and $412,746,812 in seven years. The entire deposit of domestic gold at the mint and branches, to the close of 1856 was $378,880,713, of which $360,744,914 were from California.

Agriculture.—The amount of land in California adapted to the purposes of agriculture is estimated at 41,622,400 acres, exclusive of the swamp and overflowed lands, estimated at 5,000,000; which, when reclaimed, will produce every variety of crop. On the Sacramento the experiment is being successfully made to cultivate rice with Chinese labor. The amount of grazing land is estimated at 30,000,000 acres. The amount of land under cultivation in 1856 was 578,963 acres; and of that enclosed for the purposes of agriculture about 120,000. The amount in wheat was 176,869 acres, and the product 3,979,032 bushels; in barley 154,674 acres, and the product 4,639,678 bushels; in oats 37,602 acres, and the product 1,263,359 bushels. Part of this season was characterized by a severe drought.

The president of the State Agricultural Society, in his address of 1856, says: "It is now a well ascertained fact, established by several years' experience, that California stands without a rival in respect to her capacity for producing wheat and other small grains. She produces it in larger quantities to the acre, of better quality, with more certainty, and with less labor than any other country in the known world."

Dr. Trask, in the "Geology of the State," says: "Toward the foot-hills of the mountains on the west of the San Joachim valley, is a low table of the valley, apparently destitute of water, either for the support of vegetation or animal life; in some parts this land has a slight, gravelly appearance, but this is not general. On one rancho, situated on this plateau, there have been two full crops of barley harvested from the same piece of ground, and when I visited this place, in October, the third crop was being then harrowed in, the whole having occurred within the term of 273 days."—(Page 54.)

The following extract from the report of the visiting committee for 1856 will best illustrate the extraordinary capacity of the soil for the culture of this important grain: "Near Alviso, Santa Clara county, there is a field of barley, fifty acres in extent, which has averaged the present season forty-three bushels to the acre. This is the fifth crop from a single sowing; it has received no special care, and may be regarded as a memorable example of a succession of volunteer crops."

The cultivation of the grape and its manufacture into wines and brandies is rapidly assuming a degree of importance, and increasing to such an extent that these products must soon become one of the most reliable and lucrative branches of the resources of the State. The experience of the last few years has proved conclusively that this country produces this fruit in the greatest variety and abundance; and in a few years will surpass the most extensive wine producing countries of the world. The number of vines in cultivation, in 1856, was 1,532,224, and the average yield over fifteen pounds of fruit. The number of all kinds of fruit trees that year was 1,296,783, and the fruit far superior to any on the Atlantic or Gulf seaboard.

The two great staples, cotton and flax, will soon render the country independent of other places for her manufactures; whilst the production of silk bids fair to go hand in hand with both. The true wealth of the country has but commenced its development, and in a short period she will successfully compete with the Atlantic States and Europe for the markets of the Pacific.

Regular mail communication is maintained by steamships with the Atlantic and the Gulf States twice a month; crossing the Isthmus of Panama by 47½ miles of railroad. The transit from steamer to steamer occupying four hours. For the year ending June 30, 1856, the number of letters conveyed by this route was 2,365,902, and newspapers 3,463,817; the number of letters and newspapers exchanged between the United States and Great Britain, in British mails by the Collins, Cunard, Bremen, and Havre lines, for the same time, was 3,909,128 (letters,) and 3,196,014 (newspapers.) The comparison speaks well for the modern El Dorado.

The entrance to San Francisco bay is supposed to have been first seen by Bartolome Ferrelo, pilot and successor to Juan Rodriguez Cabrillo, who, running down the coast with a gale strong from the north, on the 3d of March, 1543, descried what he supposed to be the mouth of a great river, having every appearance of draining a large extent of country; and steering SE. and E.SE. he soon after sighted Point Pinos, and on the 5th the port in the Island of Juan Rodriguez, where Cabrillo is supposed to have died. If this account be correct, he was the first European that beheld the Golden Gate.

Sir Francis Drake visited California, which he named New Albion, in 1579, and we are of opinion that in this bay he overhauled and repaired his vessel; "it having pleased God to send him into a fair and good bay, with a good wind to enter the same." Curiously enough we find the statement that "there is no part of the earth here to be taken up wherein there is not some probable show of gold and silver." The bay in which he "trimmed" his ships was certainly known before the time of Vizcaino, who having separated from his tender sought her in Port Francisco, and, according to Venega's account, "to see if anything was to be found of the San Augustine, which, in the year 1595, had, by order of his majesty and the viceroy, been sent from the Philippines by the governor to survey the coast of California, under the direction of Sebastian Rodriguez Cermeñon, a pilot of known abilities; but was driven ashore in this harbor by the violence of the wind; and amongst others on board the San Augustine was the pilot Francisco Volanos, who was also chief pilot of the squadron." Others suppose Vizcaino to have ascended San Francisco bay as far as the present site of Benicia.

Vizcaino came to anchor in the Capitana, behind the high point of land, which he called La Punta de Los Reyes.

A land discovery of the bay was made in 1769 by Gaspar de Portola, who left San Diego to establish a Jesuit colony at Monterey, but by travelling along the eastern slope of the Coast mountains he passed Monterey, and towards the close of October came unexpectedly upon the shores of a great bay, which they supposed to be the Port St. Francisco of the old navigators. Having no supplies, the party returned to San Diego.

Vancouver visited the bay in 1792 and 1793, and gives a good general map of the entrance.

The first accurate hydrographic survey was made by Capt. Fred. W. Beechy, in the Blossom, in November, 1826, he carrying his work to the Strait of Karquines.

In October, 1837, Capt. Sir Edward Belcher ascended the Sacramento with the boats of the Sulphur, and starting from the "Fork" carried the survey down the river to connect with Beechy's survey. The "Fork" he calls Point Victoria, and places in latitude 38° 46′ 47″ and 0° 47′ 31″.5 east of the observatory on Yerba Buena. The river but a short distance above his starting point was fordable, and thence to its mouth traversed in its meanderings 150 miles.

The Coast Survey charts of 1857 furnish all that can be desired in regard to the lower part of the bay of San Francisco, the upper bays, and the waters approaching the mouth of the Sacramento.

DUXBURY POINT AND REEF.

From Point Boneta to Duxbury Point, forming the west side of Ballenas bay, the course is W. by N. ¼ N., and the distance 9¼ miles, the shore-line at the base of the hills running nearly two points more to the northward to form Ballenas bay. The point is a table-land about 100 feet high, stretching along the coast for 2 or 3 miles, and gradually rising until it reaches the base of the mountains. The bay inside the point is at the foot of the mountains, and, except small crooked channels, is bare at low tides, and filled with small islets. The south side of the bay is bounded by a long, narrow sand spit, stretching so nearly across it as to leave an entrance of but 100 yards wide at the southwest part of it. Only a few small vessels run between this place and San Francisco.

Duxbury reef makes out over a mile from the southwest part of the point, and stretches directly towards Point Boneta, with 4 to 8 fathoms regular bottom of sand and mud between it and the shore to the eastward, affording safe anchorage in northerly weather.

Quite close to Duxbury Point the steamship S. S. Lewis went ashore, April 9, 1853, in a thick fog and calm, while running at her ordinary speed. She was backed off and ran ashore again within a few hundred yards to the northward, and was totally lost in the breakers.

SIR FRANCIS DRAKE'S BAY.

From the tail of Duxbury reef to the west end of Los Reyes the course is W. ¾ N., and distant 17⅛ miles. To the east end the course is W. by N., distant 14⅝ miles. From Duxbury the shore is bold and compact, running nearly NW. for about eight miles, then curving regularly to the westward until it reaches its greatest latitude at the Estero de Limantour, which bears N. by E. from the east end of Los Reyes, distant 3 miles; thence the line curves to the southward and southwest, one mile west of the point, leaving a long, high, narrow point stretching to the east, and off which the breakers extend half a mile. This curving shore-line forms Sir Francis Drake's bay, which affords a large and admirable anchorage in heavy northwest weather; and by anchoring close in under the north side of the point, in 4 or 5 fathoms, hard bottom, good but contracted anchorage is obtained in southeast gales, as the swell rolling in from the SW. is broken by the reef.

Several esteros or lagoons open into the north side of the bay, but their entrances are very narrow and shoal. The largest is the Estero de Limantour, near which the Mexican vessel Ayachucho is reported to have been wrecked in 1841.

The shore north of Boneta is bold and high, presenting a marked and peculiar undulating surface on the sea front. This characteristic is well delineated on the Coast Survey map of the approaches and entrance to San Francisco bay, published in 1857.

North of Duxbury the hard rocky shore gradually merges into cliffs, consisting chiefly of yellowish clay and sand resting upon granite, and as the surface is regularly undulating, with the direction of the alternate ridges and valleys at right angles to the shore, the wearing action of the surf forms a continuous series of round topped, bright, vertical bluffs, averaging nearly 100 feet high, and presenting a very noticeable feature from the sea. Its resemblance to portions of the coast of England was one of the reasons which induced Drake to apply the name New Albion to the country.

The mountains in the back ground rise over 2,000 feet, and the "Table Mountain" of Beechy attains an elevation of 2,570 feet, but many higher summits are found beyond. A few large red-wood trees are seen along the top of the ridge.

From South Farallone light-house Table Mountain bears NE. $\frac{1}{2}$ N., distant 24 miles; its geographical position is—

	°	′	″
Latitude	37	55	43.0 north.
Longitude	122	33	38.8 west.
	h.	m.	s.
Or, in time	8	10	14.6.

It was called Mount Palermo by the United States Exploring Expedition, but is known only by the name here used.

Point Reyes.

This is the most prominent and remarkable headland north of Point Conception. It is distinctly visible from the entrance to San Francisco bay, and the summit of the ridge presents an irregular jagged outline, with the highest part about one-fourth of its length from the western extremity. Its south face is a precipitous wall of hard sienitic granite, rising boldly from the ocean, attaining an elevation of 597 feet in 300 yards, and stretching nearly in a straight line E. by N. and W. by S. for 3 miles. This direction is peculiar on the coast, and would not be expected from a consideration of the trend of the coast mountains and of the Farallones, which are in line NW. and SE. On the north side the cape falls away regularly to a low undulating neck of land, cut up by esteros making in from Drake's bay, and from Tomales bay on the north. When made from the southward it is raised as a long, high island; but on approaching it from the westward it is projected upon the mountains running north from Table mountain, and its characteristics are not so readily recognized. Its base is very broken and rocky, and bordered by crags and hundreds of rocks, but may be boldly approached, and 8 fathoms, hard bottom, obtained within less than a quarter of a mile. Off the eastern extremity a reef makes out half a mile in continuation of the point. Upon this reef it breaks heavily in bad southerly weather, but 9 fathoms can be had close to the breakers. Off the western head a depth of 12 fathoms is found quite near to the rocks.

Vessels bound to San Francisco from the northward always make Los Reyes, and, when up to it, sight two mountains on the southern peninsula of San Francisco as islands. One of these is Blue mountain, 1,100 feet high, and the other nearly 1,300 feet.

The light-house of Punta de los Reyes is in course of construction on the western head, about a quarter of a mile from the point. It will be elevated about 500 feet, and illuminate a sector of 255 degrees. The geographical position of the site selected is—

	°	′	″	
Latitude	37	59	37.4	north.
Longitude	123	00	16	west.
	h.	*m.*	*s.*	
Or, in time	8	12	01.1	

Magnetic variation 15° 45′ E., in 1857, with a yearly increase of 1′.4.

This headland was discovered by Cabrillo in 1542, and placed by him about the latitude of 40°; but by applying the correction 1° 50′, obtained from his erroneous latitudes of San Diego, Point Conception, (Cape Galera,) and Punta Gorda, (San Martin,) the latitude of 40° becomes 38° 10′, which is within ten miles of the Los Reyes. We believe he called it Cabo Mendozino, in honor of the viceroy of Mexico who despatched him; but this name had been applied to every cape first made by the Spanish galleons on the passage from the Philippines to La Natividad, New Spain. In this region Cabrillo found the mountains covered with snow. There can be little doubt that he also saw the Farallones.

The present name was given by Vizcaino in 1603.

Los Farallones de los Frayles.—The southern and principal one of these seven small rocky islets lies off the Golden Gate, at a distance of 23½ miles; the whole group being disposed in a nearly continuous line running NW.

The South Farallone is the largest and highest, extending nearly a mile east and west, attaining an elevation of about 340 feet above the sea, and presenting to the eye a mass of broken, jagged rocks, upon which no vegetation exists, except a few stunted weeds. The rocks are sharp, angular masses, which, becoming detached by the operations of natural causes, roll down upon the more level parts of the islet and cover it with irregular boulders. Notwithstanding that it is the outcrop of an immense dyke of granite, the condition of the superficial portion is such that it could be separated into small fragments by a pick or crowbar. A more desolate and barren place can hardly be imagined. From the hills about the Golden Gate the South Farallone is plainly visible, rising in regular pyramidal form.

South Farallone light-house.—The tower stands on the highest peak of the principal island. It is built of brick, 17 feet in height, and is surmounted by a lantern and illuminating apparatus of the first order of the system of Fresnel. It is a *revolving white light showing a prolonged flash of* 10 *seconds every minute* throughout the horizon. It is elevated about 360 feet above the mean level of the sea, and should be visible, in a favorable state of the atmosphere, from a height of—

10	feet, at a	distance of	25.4	miles.
20	do.	do.	26.9	"
30	do.	do.	28.1	"
60	do.	do.	30.7	"

At near distances, under favorable circumstances, the light will not wholly disappear between the intervals of greatest brightness.

The geographical position of the light-house, as given by the Coast Survey, is—

	°	′	″	
Latitude	37	41	55.2	north.
Longitude	122	59	05	west.
	h.	m.	s.	
Or, in time	8	11	56.3.	

Magnetic variation 15° 40′ east, in 1857, with a yearly increase of 1′.4.

The bearings and distances of prominent objects from it are—

North Farallone NW. by W. 7 to 10 miles.

Western head of Los Reyes N. by W. ⅗ W. 17¾ miles.

Point Boneta light-house NE. by E. 23½ miles.

Bell-boat off San Francisco bar NE. by E. ½ E. 16½ miles.

Point San Pedro E. 23½ miles.

From abreast of Fort Point the light is just visible above the horizon.

Vessels from the westward running for the Golden Gate should keep to the southward of the South Farallone, especially in thick weather. To the westward of it a depth of 50 fathoms is obtained at a distance of 3 miles, shoaling to 20 fathoms in 2 miles; whereas, inside of it, the bottom is very regular at 30 fathoms for ten miles, and then decreases regularly to the bell-boat. On the SE. side of the island there is said to be good holding ground in 15 fathoms.

The San Francisco pilot boats cruise off the island.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is X*h.* XXXVII*m.*, and the difference between the greatest and least intervals 1*h.* 16*m.* The mean rise and fall of tides is 3.6 feet; of spring tides 4.4 feet, and of neap tides 2.8 feet. The mean duration of the flood is 6*h.* 18*m.*, and of the ebb 6*h.* 09*m.*

An extended and detailed examination around the island has not yet been made.

The Middle Farallone lies N.NW. from the South Farallone, at an estimated distance of two miles. It is a single rock of small extent, and rises 20 or 30 feet above water.

The North Farallones lie NW. by W. from the south, and distant, by estimation, from 7 to 10 miles. They form a group of five small rocky islets, rising to a height of about 150 feet, and having a pyramidal appearance, as their name denotes. They bear about S. by W. from Los Reyes, at an estimated distance of 11½ miles. Their position has not yet been accurately determined, nor has any detailed hydrographic survey been made around them.

To the southward and eastward from the North Farallone, at a distance of two miles, we are informed that a sunken rock exists, having 4 fathoms water upon it, with kelp around it, except when torn away by storms. In good weather the fishermen fish around it, but in bad weather the sea breaks upon it. We called attention to this several years ago, and since then have met with a Russian volume of charts, published at New Archangel, in 1848, wherein a rock in this vicinity is marked "overflowed." For two miles W.NW. off these islets rocky bottom is found in 25 fathoms; thence to Los Reyes the depth increases to 50 fathoms about midway.

The Farallones de los Frayles were discovered by Ferrelo in February, 1543, and he is stated to have seen six islands in this vicinity, one large and five very small, which Cabrillo had passed on the previous voyage. The five small islands were doubtless the northern group, the large one the South Farallone, and the middle might very readily be missed on account of its smallness. He states that for five days it was impossible to effect a landing upon them on account of the southwest winds and heavy sea.

Sir Francis Drake is the first that specially mentions them, in 1579, as lying off the harbor or bay where he refitted his ships.

In some recent maps they are omitted.

Point Tomales and Tomales bay.—Northward of Punta de los Reyes we find a long reach of broad white sand beach, backed by sand dunes, and extending in a N. ½ E. direction about 9 miles, gradually curving to the northwest, and changing to a high precipitous coast running to Point Tomales, which bears N. by W. 14 miles from Los Reyes. Close to the point are several high rocky islets. Vessels in thick weather should not approach this stretch of coast in less than 30 fathoms. The steep hills which commence from the sand dunes form a narrow ridge that attains an elevation of nearly 700 feet. This is about 1½ mile in width, and is bounded on the east by the bay of Tomales, which extends towards the southeast about 12 miles, and beyond the head of the Estero de Limantour, coming in from Sir Francis Drake's bay. The Bay of Tomales is narrow and very shoal, being nearly bare at low water, but having a small tortuous channel for a considerable distance up. The entrance is narrow and obstructed by a bar, having, it is reported, 18 feet water upon it at high tide. With the least swell from seaward it breaks all over the entrance.

The ship Oxford, after getting ashore on the outside of the point, floated off, drifted into this bay over the bar, grounded on the flats, and at the next high water was floated off again. Small vessels carry the agricultural products of the immediate vicinity to San Francisco, and a considerable traffic is carried on in clams, crabs, and fish.

In February, 1857, the waters of the bay changed to a deep purple color, and the fish died in such great numbers that the beaches and water were covered with them.

This bay was known as Port Juan Francisco by the Spaniards when Vancouver visited the coast in 1792. The present name was given to it on account of its peculiar shape.

Belcher erroneously designates it as a part of Bodega bay. The topography of its entrance was executed by the Coast Survey in 1853.

Bodega Head lies NW. by N. ¾ N. 18 miles from Los Reyes, and forms the northern point of Bodega bay, considering Tomales point the southern. The Head is two or three hundred feet high with a slightly rounding summit, and continues of nearly the same height for a mile or two northward, where it changes to a broad sand beach with low country near, but high hills in the back ground. The face of the land about here begins to change from its uniform want of trees to hills partially covered. It has been frequently held out as a warning not to mistake Bodega Head for Punta de los Reyes, but there exists no reasonable ground for raising a question on this subject, although navigators, who have lost or jeopardized vessels, offer as an excuse the great similarity of the coast and headlands to those near the Golden Gate. We have never been able to detect it.

BODEGA BAY.

From Tomales bay to Bodega Head the course is NW. by W. ¼ W., and distance 5 miles; while the average depth of the bay to the eastward of this line is 1½ mile. Eastward of Point Tomales the bay or roadstead acquires its full width at once by the shore running well east from the opposite side of the entrance to Tomales bay. At Bodega Head the shore runs northward to the entrance of the shallow lagoon for nearly a mile, then curves to the eastward along a low narrow sand spit for over a mile; thence southeastward in a line parallel to the two headlands. The shore about the middle of the bay becomes high, abrupt, and guarded by numerous high rocks. Inside of the low sand spit is an extensive lagoon, having small intricate channels, but almost destitute of water at low tides. The produce of the country is placed in lighters at the "port," or embarcadero, about one mile within the lagoon, and floated with the currents to the anchorage, which is about half a mile off the entrance in 5 or 6 fathoms, (hard bottom, of coarse sand and small patches of clay,) somewhat protected by Bodega Head and a rocky islet and reef extending about three-quarters of a mile off its southwest face from the full force of the northwest swell, which generally rolls in disagreeably. The reef off the Head is densely covered with kelp. During the winter season it is necessary to anchor well out to be ready to slip and run, as the sea room is very contracted and the swell heavy. Vessels in beating out must keep clear of the reef, the outline of which is well marked by the kelp. Some vessels have ridden out very heavy southeasters, but several have been lost.

The country in the vicinity of the bay is very productive, both in the valleys and upon the hills. A fine tract of agricultural country stretches behind the coast hills, extending from Russian river to Petaluma creek, by which channel the produce of this region finds its way to San Francisco.

The secondary astronomical station of the Coast Survey was upon the western end of the sand spit; its geographical position is:

	°	′	″	
Latitude	38	18	10.3,	north.
Longitude	123	02	29,	west.
	h.	*m.*	*s.*	
Or, in time	8	12	09.9	

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is XI*h.* XVII*m.*; and the difference between the greatest and least intervals is 1*h.* 54*m.* The mean rise and fall of tides is 3.6 feet; of spring tides 4.7 feet; and of neap tides 2.7 feet. The mean direction of the flood is 6*h.* 19*m.* and of the ebb 5*h.* 59*m.*

Bodega bay was discovered by Heceta and Bodega in 1775, and placed in latitude 38° 18′ north. It was partially examined by Mr. Puget, under Vancouver's direction, in 1792.

In 1812, by permission of the Spanish governor of California, it was occupied by the Russian American Company, who afterwards refused to give it up, and retained possession until 1841. They erected two large wooden houses under the bluff, at the entrance to the lagoon; but these buildings were in ruins at the time of our visit in 1853. A recent Russian work (1848) says: "The bay of Bodega (Tuliatœlivo) was fully described in 1819 by Captain Hagemeister. It is similar to the port of Trinidad, in being convenient only during the summer, when the northwest winds blow along the coast; at any other season it is dangerous. Both its indentations within the NW. and SE. headlands are shallow and contracted, and, therefore, it is necessary to anchor in the open roadstead."

In 1839, under Belcher's orders, Kellett commenced the survey of Bodega, in the schooner Starling, and was soon after joined by the Sulphur.

The line of equal magnetic variation of 16° east crosses the coast line of Bodega bay in latitude 38° 15′; and in latitude 38° 06′ crosses the 124th degree of longitude. This is for January, 1859. The line moves southward about a mile and a half annually.

Fort Ross.—The rocky, contracted, and unsafe anchorage off this place is NW. ¾ N. from Los Reyes; distance 32 miles, and 15 miles from Bodega Head. The large white buildings of the

Russians on the rising ground, and about 100 feet above the sea, are the only marks for making it, and the shore is so steep and guarded by rocks and reefs as to render approach dangerous.

No trade is now carried on here.

The approximate geographical position is:

	°	′
Latitude	38	30 north.
Longitude	123	13 west.

On some charts it is erroneously placed in Bodega bay, with a large river running from the northward into the bay. Belcher states it to be 30 miles north of Bodega.

The shore between Bodega and Fort Ross curves slightly eastward, and for several miles north of Bodega Head is bounded by a broad sand beach. Half way towards Ross the "Russian river" empties into the sea, coming through a broad valley, northward of which and some distance inland commence the high hills, covered with timber, which gradually approach the coast until only a narrow space of open rolling land is found at Fort Ross; and the Russian vessels formerly used this as the distinctive mark of its position. The coast and coast hills to the northward are mostly covered with dense forests of immense trees and thick undergrowth.

From Fort Ross to Punta de Arena the coast is almost straight, running NW. by W. ¼ W. for 37 miles. It is compact and abrupt the whole distance; covered with trees to the water's edge, and backed by an unbroken ridge of hills about 2,000 feet high, and wooded to their summits.

Haven's Anchorage.—About 24 miles northwestward along the coast from Fort Ross is a contracted anchorage under high precipitous rocky islets, with a short stretch of beach on the main affording a boat landing. There is a protection, when anchored close in, against heavy northwest weather; but it would be very difficult to recognize the locality unless the position of a vessel approaching it were accurately determined.

On the top of the bluff, at the north side of a small gulley, a secondary astronomical station of the Coast Survey was established in 1853. Its geographical position is:

	°	′	″
Latitude	38	47	58.0 north.
Longitude	123	34	00.8 west.
	h.	*m.*	*s.*
Or, in time	8	14	16.0

Northward of this anchorage high, bold rocks line the coast for four or five miles.

Punta de Arena.—This is the first prominent headland north of Los Reyes, from which it bears NW. ¼ W., distant 67 miles. Approached either from the northward or southward, it presents a long level plateau, stretching out about two miles west of the high lands, and terminating in a perpendicular bluff that averages about 200 feet in height, except the extreme northwest part, which is comparatively low, partially covered with sand, and destitute of trees for some distance inland. When seen from the southward, with the sun shining upon the face of the bluff, it shows remarkably white for the length of two miles. In fact, no point upon the coast presents such a bright appearance, or such uniform vertical bluffs, composed of hard rocks, twisted and distorted into many plications. Bold water is found close off the point outside the kelp, which, stretching strongly to the southward, shows the set and comparative strength of the current. In October, 1857, we judged it to be running at the rate of not less than two miles an hour. In July, 1853, the computed distances between the astronomical stations compared with the indications of Massey's patent log, showed a current of from one or two miles, running along the coast to the southward.

About two miles southward of the point a small contracted valley opens upon the shore and off it is an anchorage for small vessels, moderately well protected from the northwest swell, but open to the southwest. Several schooners have gone ashore here. A large bed of kelp lies off the anchorage.

About a mile and a half N. by W. from the point are several rocks showing just above water, and upon which the least swell breaks. These were noticed by Vancouver in October, 1793. When one mile broad off Arena, a high, sharp pinnacle rock shows well out from the shore on the horizon to the southward, with some rocky islets inside, and breakers well out beyond the pinnacle rock, yet northward of it; but their distances from shore are not probably as much as a mile.

The approximate geographical position of Punta de Arena is—

	° ′
Latitude	38 57 north.
Longitude	123 45 west.

A recommendation has been made for a light-house upon this point, which is much needed by the mail and coasting steamers and sailing vessels.

The appearance of this and adjacent parts of the coast induced Sir Francis Drake to call the land New Albion, whilst the same appearance and sandy line to the northward of it doubtless led the Spaniards to designate it La Punta de Arena. It suggests an inquiry concerning the numerous Cape Blancos that are found in their voyages and maps.

Albion river.—From Point Arena the first point to the northwestward is 24 miles distant, and bearing NW. by N. ¾ N. After passing Arena the coast falls to the eastward of north, and for six miles presents a low shore-line with sand beach, changing suddenly to a straight, high, bluff shore with a few trees, and backed within half a mile by hills of 2,000 feet, covered to their summits with wood. Sixteen and a half miles from Arena is the mouth of the Albion river, a very small stream, with the barest apology for a harbor at its mouth. A saw-mill upon this stream induces coasters to obtain freights here, but a great many of those trading have been lost. The Coast Surveying steamer Active passed in, but broke her anchor on the rocky bottom.

Mendocino bay.—Twenty and a half miles from Arena, and four above Albion river, is a contracted indentation called Mendocino bay, available for a few vessels in summer, but dangerous in winter. The northern and southern points are about three-quarters of a mile apart, and the eastern shore retreats nearly half a mile. At the southern head are several small rocks and one large islet surrounded by rocks, off which are heavy breakers. Midway between the heads is a small reef upon which the sea breaks heavily, with very little swell. Deep water is found close around this reef. Off the northern head is very bold water close to it. Into the northeast part of the bay enters the river *Noyon* or Rio Grande, between two and three hundred yards wide, with a good channel on the southern side, a broad sand flat on the northern, and a bar at the mouth with but a few feet of water, and upon which it always breaks. The eastern shore is bold and rocky. In the southeastern part is a sand beach, with a reef extending from its centre.

The bay forms such a slight indentation in the coast-line that it is difficult to find, without acquaintance with its minutest peculiarities, as there are no prominent marks by which to determine it. The north head is a table bluff about 60 feet high, and destitute of trees to the northward and some distance inshore. The south bluff is likewise destitute of trees, but more irregular in outline than the other. Vessels bound for it in summer work a little to windward, then run boldly in towards the north point upon which the houses become recognized; keep close as possible along the shore, gradually decreasing the distance to 100 yards just off the south end of the point in 6 fathoms; run on about 150 yards past the point; head up handsomely and anchor in 5 or 6 fathoms hard bottom. It is a bad berth in summer; and in winter a vessel must anchor far enough out to be able to slip her cable and go to sea upon the first appearance of a southeaster. Several vessels have been driven ashore here.

An extensive saw-mill is located on the north side of the river some distance up; formerly (1853) it was on the north head, and a stationary engine was placed near the mouth of the river to draw loaded cars up the inclined plane, whence they were drawn to the mill. The lumber was slid down shutes into large scows.

The place is now sometimes called Meiggsville; formerly it was Mendocino City.

The secondary astronomical station of the Coast Survey is on the north head, and its geographical position—

	°	′	″	
Latitude	39	18	06.1	north.
Longitude	123	47	25.6	west.
	h.	*m.*	*s.*	
Or, in time	8	15	09.7.	

Magnetic variation, 16° 35′ E., July, 1857; increasing about 1′.4 yearly.

From the point just north of Mendocino bay, (the first one made from Arena,) the shore runs nearly straight for 28 miles N. by W. ½ W., being low and bounded by rocks for 12 miles, when the back hills reach the water and present an almost vertical front 2,000 feet in height.

From the deepest part of the bight, the general trend of the coast to Cape Mendocino is NW. ¾ W., and distance 45 miles, and for the whole of this distance it is particularly bold and forbidding, the range of hills running parallel to the shore and rising directly from it. It has been found impossible to travel along this stretch of seaboard, and the trail turns well into the interior valleys.

For January, 1859, the line of equal magnetic variation of 17° east crosses the coast-line in latitude 39° 58′; and in latitude 39° 48′ crosses the 125° of longitude. This line moves southward about a mile and a half annually.

SHELTER COVE.

From the compact shore above described, a plateau, destitute of wood, and being from 60 to 300 feet in height, makes square out just above latitude 40° N. for a distance of half a mile, affording an anchorage from northwest winds, and may, perhaps, be regarded as a harbor of refuge for small coasters which have experienced heavy weather off Cape Mendocino, and are short of wood and water, both of which may be obtained here from one or two gulches opening upon the sea.

From Point Arena it bears NW. by N. ½ N., distant 65 miles. The whole sea-face of the bluff is bounded by thousands of rocks above and below water, and vessels coming from the north for shelter must give it a wide berth, rounding it within one-third of a mile, and anchoring in 5 fathoms, hard bottom, about one-third of a mile from shore. In this position fresh water comes down a ravine bearing about north, and an Indian village existed in 1853 at the bottom of the wooded ravine a little further to the eastward. There is always a swell here, and boat landing may not be very easy.

The secondary astronomical station of the Coast Survey was on the southeast part of the bluff, about 60 feet above the sea; its geographical position is:

	°	′	″	
Latitude	40	01	13.7	north.
Longitude	124	03	02.9	west.
	h.	*m.*	*s.*	
Or, in time......	8	16	12.2.	

Magnetic variation, 17° 02′ east, in July, 1857; increasing about 1′.4 yearly.

Upon old Spanish charts, a point in this vicinity is designated Point Delgado, doubtless referring to it.

A hydrographic sketch of Shelter Cove accompanied the Coast Survey Report for 1854.

PUNTA GORDA.

Is 17 miles NW. by W. ½ W. from Shelter Cove, and, as its name implies, is a large, bold rounding point. Half a mile off it lies a large rocky islet with rocks close in shore north of the point. From Punta de Arena it bears NW. ¾ N., distant 81 miles, and the line passing tangent to Punta Gorda runs one mile outside of Cape Mendocino.

CAPE MENDOCINO

Is 93 miles NW. ¾ N. from Punta de Arena. Here the range of coast hills from the southward appears to meet a range coming from the eastward, forming a mountainous headland of over 3,000 feet high, which is the western limit of the northwest trend of this section of the coast. The approximate geographical position of the cape is:

	°	′	
Latitude	40	25	north.
Longitude....	124	22	west.

About 3 miles broad off lies a reef, just under water, known as *Blunt's rocks* or reef, upon which the sea generally breaks. This reef was noticed by Vancouver as being about one league off shore.—(Vol. 1, page 198.) Half way between it and the cape, and a little to the southward, is a sunken rock which has been discovered within the last two or three years, but not yet accurately located. It is called Fauntleroy's rock. Steamers have passed dangerously near it, and in 1857 it was distinctly seen almost under the wheel of the steamship Commodore. Vessels can, perhaps, pass over it in smooth weather, but with a heavy sea the water must break.

To the southward, and immediately off the pitch of the cape, lie numerous rocks and rocky islets, the latter being large and high, with a peculiar pyramidal or sugar loaf appearance. None of them seem to be more than half a mile from the shore, which is almost perpendicular and destitute of a beach.

The face of the cape is very steep, rocky, and worn. Above this the general appearance is rolling, and the surface covered with timber. The pyramidal islets off it are very readily distinguished in approaching from the north or south.

From Cape Mendocino the following are the bearings and distances to headlands to the northward:

Trinidad Head, north, 39 miles.

Redding's rock, N. ¾ W., 56 miles.

Crescent City light-house, N. by W., 79½ miles

Cape Blanco or Orford, N. by W. ⅞ W., 145 miles.

The extent of shore-line from Point Boneta to this cape is about 224 miles.

It is generally stated that Juan Rodriguez Cabrillo named Cape Mendocino in honor of Don Antonio de Mendoza, the viceroy of Mexico; but the highest latitude he reached was Punta de los Reyes, to which he in reality applied that name. It is quite probable that under the lee of the rocks off this cape Ferrelo, the pilot and successor of Cabrillo, anchored on the last of February, 1543, and named it Cabo de Fortunas, (Cape of Perils,) although he places his position in latitude 43°. The next day he may have been off Trinidad Head, and experiencing heavy northerly weather, his observations might have placed him in latitude 44°, but with his vessels, adverse currents, and a dead beat to windward, he could not have made a degree of latitude in a day. Here he turned back, passed the Golden Gate on March 3, and reached the island of Santa Cruz on the 5th. It is utterly impossible that with his small crazy vessels he could make 800 miles (the distance from latitude 44° to Santa Cruz) in four days.

FALSE MENDOCINO, OR CAPE FORTUNAS

Lies northward of Cape Mendocino, distant 5 or 6 miles, and is another bold spur of mountainous headland, similar and almost as high as that cape. Between the two the shore recedes slightly, is depressed, and forms a beach receiving a small stream called Bear, or McDonald's creek, coming down through a narrow valley or gulch. Off this cape lie several rocky islets presenting the same peculiarities as those off Mendocino. There is no beach at the base of the almost perpendicular sea-face.

The vicinity of these headlands certainly deserves a detailed hydrographic and topographical survey. It is reported that soundings have been obtained well to the westward of the cape; should such prove correct, the fact will be of importance to vessels, especially steamers, bound north or south, when near the coast and enveloped in fog, as it would enable them to judge of their position and change their course.

We have ventured to call this headland Cape Fortunas, to avoid the repetition of Mendocino, and to commemorate Ferrelo's discoveries.

After passing it the shore changes to a straight, low, sandy beach, with valleys running some distance inland.

Eel River is a small stream with a bar at its mouth, and distant 14 miles from Cape Mendocino. It is very contracted and crooked, receiving the waters of a great many sloughs near its mouth, and draining a most fertile valley, which is rapidly filling up with settlers.

The first and only vessel that entered it was a schooner in the spring of 1850, when searching for Humboldt Bay. She thumped over the bar, which is said to have 9 feet of water upon it at high tide. The Indian name for the river is Weé-ot.

HUMBOLDT BAY.

The entrance to this bay lies 21 miles from the sugar loaf islet off Cape Mendocino, and the bar N. by E. 22½ miles from Blunt's rocks. The bay is situated immediately behind the low sand beach and dunes, and extends 9 miles north and 4 miles south of the entrance; being contracted to less than half a mile in width abreast of the north end of the south spit. It then expands to nearly three miles, and runs a mile and a half to the eastward of Table Bluff.

The single channel running into this portion divides into two crooked ones, which contain from one to three fathoms of water, all the rest show a bare mud flat at low tides. Abreast of the entrance it is nearly a mile in width; with extensive sands bare at low tides, lying midway between the opposite shores, and running nearly parallel with them. To the northward its average width is half a mile for a distance of 3½ miles. It then expands into a large shallow sheet of water, having two or three crooked channels through it, but the greater part being bare at low tides, showing extensive mud flats, bordered by a grassy flat nearly a mile in width. In the channel way close to the north spit, not less than 3 fathoms may be carried, increasing for three miles to 6½ fathoms. One mile north of the entrance, and on the eastern side, enters a small stream called Elk river. Two miles north of the entrance, and on the east side, is situated the town of *Bucksport*, off which a depth of 3½ fathoms is found within 150 yards of the shore. Vessels are got alongside the saw-mill wharf here at high tide to load, at low tides they rest upon the muddy bottom. The military station of Fort Humboldt is on a reservation on the bluff about 100 feet high, and immediately behind the town. On the same side, and 4 miles north of the entrance, is the town of *Eureka*, off which is a portion of the channel, having nearly 3 fathoms in it, but no channel reaching it having more than 1½ fathom. The town was laid out before this latter fact was discovered. Vessels lie at the wharves, resting on the mud at low tide. Abreast of Eureka lie several low marshy islands cut up by sloughs and ponds. The largest, called Indian island, is about a mile long (NE.) by half a mile in width. It is marked by two hillocks, surmounted by clumps of trees, near which were (1854) several wretched Indian huts. The smaller islands lie between this and the eastern shore and parallel with it. *Uniontown* is situated on the northeast shore of the bay, and can only be reached by boats at high tide. It is the starting point for the Trinity and Klamath mines. From it an extensive wharf stretches far out over the mud flat, which vessels can reach at high tides.

The southern spit from the entrance to Table Bluff does not average one quarter of a mile in width; is formed of low sand dunes and grassy hillocks, and bordered on the bay side by marsh. At the lower extremity rises *Table Bluff*, which the name well describes, to a height of about 200 feet; its western point nearly reaching the sea beach, and forming a good land mark for making the bay. Five miles east of it the hills commence rising. Abreast of the north end of the south spit rises *Red Bluff*, presenting to the entrance a perpendicular face, composed of sand and gravel colored by the decomposition of iron ore near its surface, which is 96 feet above high water, and destitute of tree or brush. The bay front of the bluff is about one-third of a mile long, gradually decreasing to the low, flat land to the north, and also falling away to the south and east. On this bluff the pilots have a flag-staff to range with known points of trees beyond, by which they cross the bar and keep the run of its changes. At the base of the highest part of this bluff we discovered, in 1854, a tooth and part of the tusk of the *elephas primigenius*. The low land on the eastern shore above Red Bluff averages half a mile in width, and runs as far as Eureka, gradually changing to marsh, and bounded by plateaux and hills covered with wood. The north spit averages half a mile in width, and its southern extremity is composed of sand dunes and grassy hillocks disposed in a marked manner parallel with the direction of the northwest winds. Two miles from the entrance trees cover the hillocks and run northward one mile, when a space of a mile occurs without them. After that they continue along the shore.

The entrance.—The bar of Humboldt bay is situated about a mile and a quarter from the entrance, or two miles from the SW. and highest part of Red Bluff. It undergoes irregular changes, depending much upon the prevalence, direction, and strength of the wind. Early in 1851 it bore NW., distant two miles from Red Bluff and about half a mile from the beach of the north spit. Three and a half fathoms were found upon it, with a width of 250 yards between the three-fathom curves, retaining nearly the same width and running on a southeast course towards the bluff, but approaching closer to the north than to the south spit. When between the two, the depth of water was increased to 11 fathoms, suddenly shoaling to four fathoms inside. Vessels kept the north spit within 150 to 250 yards on the port hand for 2 or 3 miles after entering. In the fall of 1852 the bar was reported to have moved to the northward about its entire width, and the ranges for going in, as laid down by the survey of the previous year, were entirely useless. In the spring of 1854 it was more than its previous width to the southward of its position in 1851, and the depth of water had decreased, until in June of that year, when we crossed, it was over half a mile in extent, with only 16 feet water at high tide. A bare spot then showed at the lowest tides W.NW. of the end of the south spit. We saw in that year a strange brig thump over the north sands, while on the course prescribed by the sailing directions of 1851. In 1857 less than 13 feet at high tide could be found upon it, and its extent was very much increased. Eventually a deep and narrow channel will be cut through. About 1852 a steam-tug was placed upon the bay, and has rendered the most efficient service in determining the changes of the bar. When vessels are seen approaching the bar a flag is hoisted on Red Bluff, and the tug goes out to take them in. If it is breaking so heavily on the bar that she cannot get through it, and it is yet practicable for the vessel to run in, she takes up a position and hoists her flag as a signal for the vessel to steer for her. She is invaluable in towing out the deeply laden lumber vessels, as the summer winds blow directly in the channel. In June, 1851, upon our first entering this bay, we found a brig, deeply laden with spars, waiting for an opportunity to get out. She had made several attempts to beat through the then narrow channel, but always failed, and had in this manner occupied 31 days. We have laid 14 days off the entrance, and passed in when the water was breaking on the bar. A preliminary chart of the entrance to Humboldt bay was issued from the Coast Survey Office in 1851.

The Humboldt bay light-house is erected on the north spit, three quarters of a mile north of the entrance, and about midway between the bay and sea shores. It consists of a keeper's dwelling, of one and a half story, with a tower rising 21 feet above the roof from the centre; both being plastered and whitewashed, and surmounted by an iron lantern painted red. The light is a *fixed white light* of the fourth order of the system of Fresnel, and illuminates the entire horizon. It is elevated 53 feet above high water spring tides, and should be seen in clear weather from a height of—

10 feet at a distance of 12 miles.
20 feet at a distance of $13\frac{1}{2}$ miles.
30 feet at a distance of $14\frac{1}{2}$ miles.

Its geographical position, as determined by the Coast Survey, is:

	°	′	″	
Latitude	40	46	03.6	north.
Longitude	124	12	21	west.
	h.	m.	s.	
Or, in time	8	16	49.4.	

Magnetic variation, 17° 06′ east, in July, 1853, increasing about 1′.4 yearly.

The light was first exhibited December 20, 1856, and shows from sunset to sunrise.

A light on Red Bluff, which is nearly 100 feet high, would always serve as a leading range, as the flag-staff and ensign placed there are now thus used by the pilots. The light would be distinguishable readily at sea, when the present one might be obscured by the mist hanging over the surf on the beach. During the day the white buildings would be a capital mark against the green hills and trees in the back ground. This view, now and formerly expressed, has been repeatedly and earnestly urged upon our attention by many captains, merchants, and the pilots of Humboldt bay.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is $XII^h\ II^m$, and the difference between the greatest and least intervals is $1h.\ 11m.$ The mean rise and fall of tides is 4.4 feet; of spring tides, 5.5 feet; and of neap tides, 3.5 feet. The mean duration of the flood is $6h.\ 19m.$; and of the ebb, $6h.\ 00m.$

From experiments made in 1854, we found the ebb current to run 3 miles per hour, with a maximum velocity of between 4 and 5 miles.

The primary astronomical station of the Coast Survey was on the southwest part of Red Bluff. Its geographical position is: latitude 40° 44′ 40″.2 north; longitude 124° 12′ west; or, in time, $8h.\ 16m.\ 48s.$ Magnetic variation, 17° 04′ east, in April, 1854.

A secondary astronomical station was occupied in the reconnaissance of 1853 on the beach at Bucksport. Its geographical position is: latitude 40° 46′ 37″.1 north; longitude 124° 10′ 44″ west; or, in time, $8h.\ 16m.\ 42.9s.$ Magnetic variation, 17° 06′, in July, 1853.

We have already mentioned the situations of three of the towns on Humboldt bay. *Humboldt*, the fourth town, is located on the south side of Red Bluff. It had eight or ten houses in 1854, and was going backward. Bucksport has a goodly number of houses and one saw-mill, formed by hauling the steamer Commodore Preble on the beach, and using her engines for motive power. Eureka has eight saw-mills and a grist-mill, and presents a thriving appearance; one of the saw-mills is formed by the steamboat Santa Clara. Uniontown has one saw-mill. In 1854 we obtained a statement of the commerce of the bay for a period of eleven months, ending May 31 of that year; from which it appeared that 143 vessels, ranging from 71 to 540 tons, with an aggregate of 22,060 tons, had brought to the bay 3,089 tons of merchandise and 562 passengers, and taken away 18,932,000 feet of lumber. Since that time other mills have been added, with increased power, and at a low estimate we may safely say that all can turn out an average of 120,000 feet per day. Many of the vessels trading to this bay were ill adapted to contend against the summer winds. The average time of the above vessels from San Francisco was a trifle under 12 days. Some beat up in 6 days; others required over 20; all, however, are in very light ballast trim. With vessels adapted to the trade, the average time up should not exceed 8 days, and the passage to leeward would average about 4. The average tonnage had regularly increased, and there had been a decrease in the average length of the passage to the windward.

It has been erroneously asserted that this bay was discovered from sea in April, 1850, and by land in 1849; but the following account from a recent Russian work, (1848,) with an accompanying chart, settles that question:

"About 8½ miles from the port of Trinidad is situated the entrance to the Bay of Indians, called entrance of Rezanof. By the colonial documents of the Russian-American Company, it appears that it was discovered by citizens of the United States. In 1806 there was in it, (on an American vessel,) under command of Vintep, [Vén tep] a beaver party of Aleutians, under the direction of Slabotchikoff, which was met by the Indians inimically. This bay is not fully described, but it is known that it is very large; somewhat resembles the bay of San Francisco, only the entrance to it for vessels of large class is not convenient, and with strong southwest winds it is even impossible with any vessel. The depth at the entrance is two sajhen, (14 feet,) and then it breaks on the bar."

The present name was given to the bay in 1850.

Mad river is said to empty into the sea about a mile north of Humboldt bay. It averages about 100 yards in width, with a bar at its entrance that prevents egress; but the vast amount of timber in the valley must eventually find a passage through a canal to the northwest point of Humboldt bay. A deep slough from the latter is said to approach quite close to Mad river, thus favoring the execution of such a project.

TRINIDAD HEAD AND BAY.

Trinidad Head lies N. $\frac{1}{2}$ W. 17$\frac{1}{2}$ miles from the bar of Humboldt bay, and north 39 miles from Cape Mendocino. The low sand beach off Humboldt continues past Mad river to within a couple of miles of Trinidad bay, when it changes to a bluff, guarded by innumerable rocks. For the entire distance of the low beach a depth of from 10 to 15 fathoms may be found one mile from the shore.

The bay or roadstead of Trinidad is very contracted; but having deep water, and all dangers visible, forms a moderately good summer anchorage. The "Head" forming the western shore of the roadstead, and a prominent mark when seen from close in, is about 375 feet high, covered with a low, thick undergrowth of scrub bushes; has very steep sides, and 8 fathoms close to its southern base. Off the western face, for nearly half a mile out, lie several high rocky islets, with one half a mile south of it, but having 9 fathoms close to it. From the south face eastward to the 3-fathom curve the distance is one mile, and the depth of the bight to the northward of this line is about half a mile, with half a dozen rocks lying outside the 3-fathom line, but well above water. In the northern part of the bay there is a sand beach extending about half a mile; thence eastward the shore is very rocky, the bluff being about 300 feet high, and covered with a heavy growth of timber. The town, formerly a place of some promise, fronts on the northwest part of the roadstead, and the boat landing is on the north side of a round knoll making out about 100 yards from the low neck running to the "Head." A very considerable quantity of sea weed lies off here.

A hydrographic sketch of the bay and view of Trinidad Head accompanied the Coast Survey Report for 1851.

In working into the anchorage beat in boldly past the outermost rock until the rock just off the eastern side of the Head is in range with the knoll (having a few trees upon it) between the town and the Head, with the south face of the Head bearing W. by N., and anchor in seven fathoms, hard bottom, within one-third of a mile of the rock and Head, having the neck visible to the westward of the knoll, and a sugar loaf rock beyond the neck showing over it. A swell will generally be found setting in. In winter it is a dangerous anchorage, and if a vessel is unluckily caught, her chances of riding out a southeaster are very few. Several Spanish vessels were wrecked here when it was visited by them, and a number of vessels have been lost within the last eight years.

Pages 369-72 inc. missing when rec'd. G. J. O.

called *Smith's river.* The entrance to this river we looked for in vain from the deck of the steamer, although scarcely two miles off shore, but were able to form a good estimate as to where it should open by the peculiarities of the northern bank, which was a low perpendicular bluff. Its approximate geographical position is:

	°	'	
Latitude	41	54	north.
Longitude	124	11	west.

The "Smith's river" of recent maps and descriptions is a myth. North of this small stream the coast acquires an elevation of about one or two hundred feet for a short distance inland, and is bounded by high mountains.

COAST OF OREGON.

About three miles by the shore to the northward from the deepest part of St. George's bay, the boundary line of California and Oregon, of 42° N. latitude, strikes the coast near a noticeable high pyramidal mound, rising abruptly from the plateau, which is destitute of timber.

CHEKTO RIVER.

Five miles from the deepest part of St. George's bay, and in latitude 42° 01′ N., longitude 124° 15′ W., (both approximate,) empties a stream which is from 50 to 60 yards wide at its mouth, with banks about 100 feet high, and bounded half a mile inshore by very high hills. It appears deep and sluggish, and in August, 1853, was completely closed at the mouth by a heavy gravel beach. The anchorage off it is open and exposed from west to south, with several reefs in and around it. No survey or reconnaissance has been made. We found Indian huts in great numbers upon both banks, but most of the Indians were engaged higher up the stream in taking salmon.

On the Coast Survey charts of 1853 this stream was marked *Illinois river.*

From Point St. George to an arched rock about 40 feet high, in latitude 42° 11′, the course is NW. by N. 27 miles. The coast between the Chekto and the point within a mile of the arch is high, bold, compact, and bordered by vast numbers of rocks, with very deep water close inshore. From this the shore runs nearly NW. by N. ½ N. for 40 miles to Cape Orford, making a long gentle curve of 4 miles to the eastward, and being in general high, abrupt, and rocky.

ROGUE'S RIVER.

Within the long stretch just referred to is found the entrance of Rogue's river, in latitude 42° 25′ N. and longitude 124° 22′ W., both approximate, having a long, low, sandy point on the south side, and a high, steep hill, with two large rocks off its base at the north side. It comes from the interior between high mountains, and it is next to impossible to travel along its course. Just within the entrance and on the north side were large Indian villages in 1853. When passing it in moderate northwest weather the sea was breaking heavily across the bar, and this is reported to be generally the case. It has not been examined or surveyed, and the depth of water on the bar is variously reported from 10 to 18 feet; the former, doubtless, nearer the truth. McArthur reports ten feet on the bar, but that the channel is too narrow for sailing vessels to turn in. In the spring of 1850 the New York pilot boat W. G. Hagstaff entered the river, and we believe was attacked by the Indians, deserted, plundered, and burnt. The next vessel that entered was the schooner Sam. Roberts, in July of the same year, which got out safely. We know of no other vessels ever having made the attempt.

Near the entrance commences the detached deposits of auriferous sand and gravel, which are found northward along the coast to the Coquille river.

The name of the river was suggested by the dishonest propensities of the natives in its vicinity. On the maps it is called Toutounis, and the Too-too-tut-na or Klamet. These names, we judge, have arisen from misapprehension, because the Indians hereabouts when asked a question which they do not understand, answered toó-ta, toó-ta, toó-ta, signifying negation, and rendered more emphatic by repetition. Or the name may be derived from the Too-too-tan village, some distance up the river. That existing (1853) on the north head of the mouth of the river is Tar-shoots. Several campaigns have been made against the Rogue River Indians, and they have been found a warlike and troublesome race; but the manner in which they were treated by some of the early settlers was well calculated to rouse them to a war of retaliation.

ROGUE'S RIVER REEF.

The rocky islets composing this reef are not so large as the Dragon rocks, and run more nearly parallel with the coast line. The southern group of rocks lies W. ½ N., about four miles from the north head of the entrance to Rogue's river, and stretches northward three miles, where a gap occurs between them, and another cluster lying a mile and a half off shore. Off this inner group lie several dangerous sunken rocks, which must be sharply watched from aloft when the sea is not heavy enough to break upon them. As seen from the southward, the inside rock of the outer group shows a perpendicular face eastward, and sloping back to the west. The channel through this reef is perhaps a mile wide, but more dangerous than any other on the coast. No hydrographic survey has been made of it, and it is never used by the coasting steamers.

Abreast of the northern part of this reef is a five-mile stretch of low sand beach, backed by high, rugged, wooded hills, when the shore changes to an abrupt and precipitous face to Port Orford. Many rocks closely border the shore, and five miles south of Port Orford a high rocky islet lies nearly a mile off the base of a hill about 1,000 feet high.

PORT ORFORD.

This is by far the best summer roadstead on the coast between Los Reyes and the Strait of Juan de Fuca. From the extremity of the SW. point eastward to the main shore the distance is two miles, and from this line to the greatest bend of the shore northward the distance is one mile. The soundings within this space range from 16 fathoms close to Tichenor's Rock, forming the SW. point of the bay, to 3 fathoms within one-quarter of a mile of the beach on the northeast side; with 5 fathoms at the base of the rocky points on the northwest side towards Tichenor's Rock, one mile off the shores of the bay, the average depth is about 14 fathoms, regularly decreasing inshore.

The point forming the western part of the bay presents a very rugged, precipitous outline, and attains an elevation of 350 feet. Its surface is covered with excellent soil and with a sparse growth of fir. From this point the shore becomes depressed to about 60 feet at the northern or middle part of the shore of the bay where the town is located. The hills behind are covered with a thick growth of fir and cedar.

The anchorage is usually made with the eastern end of the town bearing north, being just open to the east of a high rock on the beach, in 6 fathoms water, hard bottom; having a sharp, high point bearing NW. by W. one-quarter of a mile distant, the beach in front of the town distant a quarter of a mile; and three rocks just in the three-fathom line E. by N., distant half a mile. Steamers anchor a little to the eastward of this position, and closer to the town, in 4 fathoms. Coasters from the south in summer beat up close inshore, stretching inside of the outlying islets to avoid the heavy swell outside. Coming from the northward they keep just outside of a high rock one-third of a mile off the western head, and round Tichenor's Rock within half a mile. In winter anchor far enough out to be ready to put to sea when a south-easter comes up. During a protracted gale in December, 1851, a terrible sea rolled in that no vessel could have ridden out. The old steamer Sea Gull was driven northward, and lost two weeks in regaining her position, and the mail steamer Columbia hardly held her own for many hours off the Orford reef.

The usual landing is between the rock called Battle Rock, north of the anchorage, and the point of rock close on its west side. A road is cut from here up to the town, which consists of but a few houses. Sometimes a landing is made on the rocky beach a quarter of a mile westward of Battle Rock, in the bight where a sloping grassy bluff comes to the water; but this landing is over a rocky bottom. A road is cut up the slope to the site of the military post of Port Orford, which is now abandoned.

From "Battle Rock" the shore eastward is skirted by sand beach for $1\frac{3}{4}$ mile to a rough, rocky point called Coal Point. About midway in this distance empties a small creek, whose banks are composed of a deposit of auriferous sand and gravel, the same as found in front of the town abreast of Battle Rock, and which has yielded as high as \$30 to \$40 per diem to each miner.

Several attempts have been made to open a road from this place to the mines about 60 or 70 miles eastward, but thus far without success. Several parties have gone through, but could find no direct available route for pack animals. Upon the opening of such a road it would become a large depot of supply for the interior. In the neighborhood of Port Orford are found immense quantities of the largest and finest white cedar on the coast, and for some years a saw-mill has been in operation, affording a small supply for the San Francisco market of this lumber, unapproachable in quality by any on the Atlantic coast.

The primary astronomical station of the Coast Survey, established here in 1851, is on the top of the ridge just west of the town, at a height of 262 feet above the sea, and within a few yards of the western edge of the bluff. Its geographical position is:

	° ′ ″
Latitude	42 44 21.7 north.
Longitude	124 28 47 west.
	h. m. s.
Or, in time	8 17 55.2

Magnetic variation 18° 29′ east, in November, 1851, with a yearly increase of about 1′.4. From this station Tichenor's Rock bears S. by W., three quarters of a mile distant.

The secondary astronomical station (1853) is in front of the town, north of Battle Rock, and within 50 yards of the edge of the bluff. Its geographical position is:

	° ′ ″
Latitude	42 44 28.2 north.
Longitude	124 28 13 west.
	h. m. s.
Or, in time	8 17 52.8

Tides.—The correct establishment or mean interval between the time of the moon's transit and the time of high water is XI*h.* XXVI*m.* The mean rise and fall of tides is 5.1 feet; of spring tides 6.8 feet, and of neap tides 3.7 feet. The mean duration of the flood is 6*h.* 19*m.*, of the ebb, 6*h.* 7*m.*, and of the stand 0*h.* 39*m.* The average difference between the corrected establishment of the a. m. and p. m. tides of the same day is 1*h.* 22*m.* for high water and 0*h.* 40*m.* for low water. The differences when the moon's declination is greatest are 2*h.* 12*m.* and 1*h.* 28*m.*, respectively. The average difference in height of those two tides is 1.4 foot for the high waters, and 2.6 feet for the low waters. When the moon's declination is greatest those differences are 2.3 feet and 3.9 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 7.1 feet, and when the moon's declination is greatest 8.2 feet. The highest high water in the twenty-four hours occurs about 10*h.* 45*m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about 1*h.* 14*m.* before when south. The lowest of the low waters occurs about 7 hours after the highest high water.

This bay was called Ewing Harbor in 1850 by McArthur, but is now known by no other name than Port Orford, from its proximity to Cape Orford. A sketch of it was published by the Coast Survey Office in 1854.

From the western extremity of Port Orford, Cape Orford or Blanco bears NW. ½ N., distant 6 miles, the shore line between them curving eastward about a mile. Immediately north of Port Orford it is composed of a very broad, loose sand beach, backed by a long uniform sand ridge of 100 feet height, covered with grass, fern, sallal bushes, and a few firs; while behind this the ground falls and forms lagoons and marshes. This ridge extends nearly to the mouth of a stream called *Elk river*, 3½ miles from Tichenor's Rock. This narrow stream, fordable at its mouth at low tides, comes for miles through broad marshes covered with fir and white cedar, and an almost impenetrable undergrowth. The south side at the mouth is low, sandy, and flat; the north side, a slope rising from the marsh inshore and terminating on the beach in a perpendicular bluff, averaging 100 feet high, covered with timber to its very edge for a couple of miles, when the timber retreats some distance inland. The face of this bluff exhibits vast numbers of fossil shells in the sandstone. At its base a sand beach exists which may be travelled at low water.

CAPE ORFORD, OR BLANCO.

In making this cape from the northward or southward it presents a great similarity to Point Conception; appearing first as an island, because the neck connecting it with the main is comparatively low, flat, and destitute of trees, with which the cape is heavily covered to the edge of the cliff. It is, perhaps, over 200 feet high, but the trees upon it make it appear at least 100 feet more. The sides are very steep, and worn away by the action of the sea, showing a dull whitish appearance usually, but bright when the sun is shining upon them. At the base are many black rocks and ledges stretching out to form the inner part of Orford reef. In the bend, southeast of the cape, rises a large, high, single rock, about 100 yards from the beach.

The approximate geographical position of the cape is:

	° ′
Latitude	42 50 north.
Longitude	124 30 west.

Being thus the most western part of the main land until we reach latitude 47° 50′.

From it Cape Mendocino bears S. by E. ⅞ E., distant 145 miles; Cape Disappointment light, at the north head of the entrance to the Columbia, N. by W. ⅛ W., distant 207 miles; and

Tatoosh island light, off Cape Flattery, N.NW., 332 miles. From the line joining Blanco and Cape Disappointment the coast does not, in any place, leave it more than 12 miles.

A light of the first order is required upon this cape, or upon one of the rocky islets of the outlying reef.

Upon old Spanish maps a cape near this latitude has been called Blanco, from the assertion that Antonio Flores discovered and so named it in 1603. He says that from this cape the coast trends northwest, and near it he found a large river which he tried to enter, but could not on account of the strong current running out.

At that time the magnetic declination must have been about zero, and perhaps several degrees west. Assuming it as zero, the coast thence northward for nearly 100 miles trended N. by E. $\frac{1}{2}$ E. In a translation of Russian voyages to the northwest coast, published in 1761, we find a cape laid down in latitude $42\frac{1}{2}^\circ$ called C. Blanco de San Sebastian, thus combining Vizcaino's discovery and his pilot's.—(See remarks upon Point St. George.)

The name Orford was given by Vancouver, in 1792, and placed by him in latitude 42° 52′. On the western coast this name is now almost invariably used.

ORFORD REEF.

About 4 miles off the coast, between Port and Cape Orford, lies a group of rocky islets and sunken rocks. There are seven large, high ones within an area of one square mile, with small ones that are just awash, and others upon which the sea only breaks in very heavy weather.

The southeastern rock is called the "Fin rock," and has a perpendicular face to the southwest, with a sloping surface to the northeast. Near it are several low, black rocks. The Fin rock lies W. $\frac{3}{4}$ N., distant $4\frac{1}{3}$ miles from the western point of Port Orford, but the general direction of the other six is N.NW. from Fin rock. West from Port Orford, and distant $4\frac{1}{2}$ miles, is a small, black rock, and near it a smaller one, upon which the sea breaks only occasionally. W. by N. $\frac{1}{2}$ N., distant $4\frac{3}{4}$ miles from Port Orford, lies the largest of the seven islets, rising up with high and nearly perpendicular sides. On the same course, and a mile and a quarter further out, is a small rock, and half way between them a rock awash. This is the northern limit of the group.

Stretching S.SW. for a mile and a third from Cape Orford are numerous rocky islets and sunken rocks, with large fields of kelp; but ceasing at that distance, a passage is left one and a half mile wide between them and the northern islets of the outer group. The course through the middle of the passage, clearing the rock called Klooqueh, off the western point of Port Orford, is NW. by W., with ten fathoms rocky bottom on the shoalest part of that line.

This passage is in constant use by mail and coasting steamers, but the hydrography of the reef has not yet been executed, and only a preliminary examination of the position of the outer rocks. Although the general trend of the southern group is N.NW., it is very probable that they are a continuation of the reef making out from the cape.

One mile north of Cape Orford empties a small stream having a great number of rocks off its mouth. In 1851 it was usually called Sikhs river, the "jargon" name for friend. On some maps we find a stream near this locality called the Sequalchin river. The village upon the Sikhs is called Te-chéh-quut.

From Point Boneta to Cape Orford the extent of shore line is 388 miles; Boneta to Mendocino being 223 miles.

General features.—From Cape Mendocino the hills upon the seaboard range about 3,000 feet high, running parallel with the coast at a distance of from 3 to 5 miles; receding somewhat at the Eel river valley and Point St. George; and at other points coming abruptly to the ocean. The whole face of the country is covered with dense forests. and offers almost insurmountable obstacles to the opening of roads intended to strike the trail leading along the valleys of the Sacramento and Wallamut.

Northward of Cape Orford the appearance and nature of the coast assumes a marked change. Long reaches of low white sand beach occur, and sand dunes, broken by bold rocky headlands, and backed by high irregular ridges of mountains. On the sea-face and southern sides of many of these prominent points no timber grows, and they present a bright lively green of fern, grass, and bushes. The general altitude of the mountains appears the same as to the southward.

COQUILLE RIVER.

From Cape Orford to the mouth of the Coquille, in latitude 43° 7′, the coast runs exactly north, with a slight curve of a mile and a half eastward, and a short distance north of Orford consists of a low sand beach, immediately behind which are long shallow lagoons receiving the water from the mountains, but having no visible outlet to the sea. Along this shore the soundings range from 7 to 15 fathoms at a distance of a mile.

The south point of the entrance to this river is a high bluff headland, whilst the north point is a long, low, narrow spit of sand, overlapping, as it were, the southern head, so that the channel runs parallel with and close under it, (1851.) A short distance off it lie several rocks, but not of sufficient size to lessen the western swell which breaks continually across the bar. The widest part of the mouth is less than 100 yards, after which the river spreads out into a large sheet of shallow water, about two miles long by three-quarters of a mile broad, and bounded by low ground. Into the northeast part of this lagoon enters the river, which has been followed a distance of about 30 miles in a northeasterly direction, and having a depth throughout of not less than 15 feet, and an average width of 40 yards. It drains a very fertile region, densely covered with many varieties of wood. Numerous Indian encampments were found along its banks from the mouth, and quite extensive fish weirs were discovered and destroyed.

When off the entrance, in 1854, we saw about a dozen houses which had been built by the miners engaged in washing the auriferous sand and gravel at the back of the beach. In approaching this coast we encountered a very heavy swell, with the water changing to a dark brown color, and after passing through it tacked off shore, hove to, and sounded near its outer limit, but found no bottom with 84 fathoms of line.

The alleged depredations of the Indians in this section led to a campaign against them in 1851.

Some recent maps have a river here, called the Soquils, and one within a short distance called the Cotamyts, but no such stream exists in this vicinity.

CAPE GREGORY.

Between the Coquille river and this headland we find another low sand beach for ten miles to the south part of Gregory, which rises up very precipitously; the hill attaining perhaps 2,000 feet elevation two miles back, runs in a straight line northward for three or four miles, and bounded by many rocks, slopes to the northward to a perpendicular point, about 60 feet high, and peculiarly cut and worn by the action of the sea. Thence it takes a sharp turn to the E.NE. for two miles, to the bar off the entrance to Koos bay. The cape, as seen from the southward, shows a couple of rocks a short distance from its western point. Along the low shore soundings in 10 fathoms are found one mile off. We have been informed that vessels anchoring close under the north face of the cape may ride out heavy southeast gales. If so, it is very important, no other place between Sir Francis Drake's and Neé-ah bay, except, perhaps, under Destruction island, affording that protection. If a southeaster should haul to the SW., and then NW., as they usually do, the chances of getting out would be very few.

The approximate geographical position of the NW. point of the cape is:

	°	′	
Latitude	43	20	north.
Longitude	124	20	west.

And it bears north 30 miles from Cape Orford.

It was named by Captain Cook, who placed it by bearings in latitude 43° 30′, and is described by him as follows: "This point is rendered remarkable by the land of it rising immediately from the sea to a tolerable height, and that on each side of it is very low." Vancouver placed it in 43° 23′.

It is sometimes called by the recent appellation of Arago, which has been adopted on the Coast Survey charts. It is known by both on the western coast.

KOOS BAY.

Nearly 3 miles E.NE. of the northern extremity of Cape Gregory is the wide and well marked entrance to Koos bay. The south head is high and bold, being the base of the hills forming the cape, whilst the north point is low and sandy, with small sand dunes. We cannot state their distance apart. On the bar, extending some distance out, a depth of only 9 to 9½ feet of water is found, but several small coasting steamers pass over, and not unfrequently thump upon it. The bay presents the appearance of a long lagoon having two branches, one stretching southeast from the entrance, and the other following the trend of the coast northward. Traffic is drawn hither by the mining of the coal (lignite) which is carried to the San Francisco market, but is found unfit for steamship consumption. The geology of the country does not give promise of coal.

We have seen the sea breaking completely across the entrance in moderate northwest weather, and know that the mail steamer has tried to enter, but upon seeing the danger would not take the risk.

The name Koos is that approaching nearest the Indian pronunciation of the word. On some maps we find a small stream called Cahoos, disemboguing just south of Cape Gregory. The name on the Coast Survey charts is Kowes, being that used on the first reconnaissance.

The word Koos signifies, in the Too-too-tan language, a lake, lagoon, or land-locked bay. Duflot de Mofras translates it R. des Vaches.

In January, 1859, the line of *equal magnetic variation* of 19° east crosses the coast-line in latitude 43° 39′, and in latitude 43° 29′, crosses the 125° of longitude. This line moves annually southward about 1½ mile.

UMPQUAH RIVER.

North of Koos bay to the Umpquah river is another straight, low sand beach, with sand dunes, backed by a high ridge of hills densely timbered. The shore runs nearly north, presenting a very white appearance when the sun shines upon it, and having from 10 to 15 fathoms of water one mile off the beach. The southern point of the entrance to the river is a marked spur of the mountains from the southeast, and is bordered by sand dunes. The north side of the entrance is a long range of white shifting sand hills, running with the coast for two miles, and suddenly changing to high, rocky hills covered with wood. The river is the largest stream entering the Pacific between the Sacramento and the Columbia rivers. It is 51 miles N. $\frac{1}{3}$ W. from Cape Orford, and 21 miles north of Cape Gregory. The entrance is long and narrow, running nearly north for 5 miles; bordered on the south side by a rocky, wooded shore; on the north, for two miles, by loose sand hills, changing, after the first mile, to sand sparsely covered with coarse grass, bushes, and fir, and in 4 miles to steep, high, rocky banks, covered with large trees. An immense flat, mostly bare at low water, stretches south from the north point to within 300 yards of the south side of the entrance, through which narrow space runs the channel, having (1853) a bar with only 13 feet upon it, and less than 100 yards wide. From the bar the point of bluff, just inside the entrance, bears NE. by E., and is distant $1\frac{1}{4}$ mile. About 1851 or 1852, two range marks were placed on the south shore for running in by, and they are frequently referred to as data by which to trace the changes of the bar; but the captain who erected them has assured us that the bar was not on their range, but to the southward of it.

Buoys for crossing the bar.—In January, 1858, it was announced that the bar had been marked by buoys. Two third class nun-buoys, painted white with white and black perpendicular stripes, are placed in line with the light-house, which bears from them E. by N. $\frac{1}{4}$ N. The inner buoy is just within the bar, and in $3\frac{1}{2}$ fathoms at mean low water, and can be passed on either hand, but only close to it. The outer buoy is just outside the bar in 10 fathoms at the same stage of the tide, and can also be passed on either hand. Keeping the two buoys in range with the light-house, 14 feet may be carried over the bar at mean low water.

The above directions show that the bar of the river has moved about 400 yards to the northward of its position, as determined by the hydrographic survey of 1853, and has, moreover, deepened. In light weather it can be readily determined by the breakers on each side, but with a heavy swell the sea is terrific. In October, 1852, the Coast Surveying steamer Active lay off the bar two days trying to get in, but found it impracticable. Several steamers have thumped heavily on the bar, one nearly carrying away her sternpost, and in 1858 the mail steamship Columbia in coming out had her decks swept fore and half by the huge combers rolling in like high walls. Several vessels have been lost at its entrance, and within a very recent period no pilots belonged to the river, because the trade was too small to pay.

During the early part of November, 1858, the bar at the entrance to the Umpquah changed greatly, and the depth of water upon it was so much decreased that the steamship Columbia, which thumped over it, could not leave the river for several weeks. Upon sounding at the entrance it was found that the channel across the bar had moved about half a mile northward of its former position.

UMPQUAH RIVER LIGHT-HOUSE.

The light-house is erected on the south side of the entrance, close to the beach, which is of shifting sand. The structure consists of a keeper's dwelling of stone, with a whitewashed tower of brick rising above it, and surmounted by an iron lantern painted red; the entire height being 92 feet, and the height of the light 100 feet above the mean sea level. The light is a *fixed white light* of the third order of the system of Fresnel. It was first exhibited October 10, 1857, and shows every night from sunset to sunrise. In an ordinary state of the atmosphere it should be seen from a height of 10 feet at a distance of 15 miles; 20 feet at a distance of 16½ miles; 30 feet at a distance of 17¾ miles.

In the day time the town will show projected against the dark green fir on the hills behind it, and with the sand dunes to the north, be a capital mark for making the river.

The geographical position of the light, as determined by the Coast Survey, is:

	°	′	″	
Latitude	43	40	18.5	north.
Longitude	124	11	0.3	west.
	h.	*m.*	*s.*	
Or, in time	8	16	44.2.	

Magnetic variation 18° 55′ east, in July, 1851, with a yearly increase of 1′.4.

From the bar the light bears E. by N. ¼ N., distant about a mile, (1858.) After crossing the bar the channel, when approaching the light-house, runs close to the south shore, and increases in depth from 3½ fathoms to 13 off the point of bluff. Abreast of the meeting of the sand beach and bluff, and on the south side, lies a rock, visible at extreme low tide, upon the three-fathom curve. It is not laid down on any chart. From the point of bluff vessels steer across the river to strike the east side of the north point, about one-third of a mile from its extremity; then haul across E.NE. to the other shore, close along which the channel runs; this course takes them clear of a flat and rocks in mid-river, and bearing E.NE. from the south end of the north point. The small indentation of the shore line on the right, after making the first stretch from the point of bluff, is called Winchester bay, having no water, and being but an extensive mud flat; three miles inside the light-house the river continues half a mile wide, then expands to a mile, and is filled with numerous extensive sand and mud flats. Five miles from the light-house it bends sharply to the eastward.

A preliminary chart of the entrance to Umpquah river was issued from the Coast Survey Office in 1854.

The secondary astronomical station of the Coast Survey was on the west side of the river on the edge of the first grove of fir, and one mile from the end of the north point. Its geographical position is:

	°	′	′	
Latitude	43	41	453.	north.
Longitude	124	09	57.0	west.
	h.	*m.*	*s.*	
Or, in time	8	16	39.8.	

This river is said to drain an extremely fertile region abounding in prairie land well adapted to agriculture and grazing. Ross Cox mentions a pine tree discovered in the Umpquah valley measuring 216 feet to its lowest branches, and being 57 feet in circumference.

The Indian name for the river below the rapids is Kah-la-wat-set, and to the upper part they apply the name Umpt'quah.

The first vessel we know of entering it was the schooner Sam Roberts, August 4, 1850, after coming out of Rogue's river.

This river is sometimes supposed to be the river discovered by Flores in 1603, and afterwards referred to as the "River of the West."

From the Umpquah the coast runs in a remarkably straight line N. by W. ½ W. to the south point of the entrance to the Columbia river, in no case varying more than 3 miles inside the line joining these two places.

Bank.—NW. by N., distant 66 miles from Cape Orford, is the southern end of a bank extending parallel with the coast for 30 miles, and about the same distance from it. The least depth yet discovered upon it is 43 fathoms, and the nature of the bottom very variable, there being blue mud, coarse blue sand, coral, pebbles, gravel, mud, and shells. Coasting vessels have often reported passing over localities having a heavy swell upon them, and one frequently so reported near the Umpquah led to the examination which discovered this. When Heceta was upon this coast, and in this vicinity, he said: "On Sunday I found great differences [of depth;] at 7 leagues I got bottom at 80 fathoms; and nearer the coast I sometimes found no bottom." Should a thorough examination of his discoveries here satisfactorily show that he did really cross this or any yet undiscovered adjacent bank, it would be a tribute to his explorations on this coast to apply his name to it.

CAPE PERPETUA.

After leaving the Umpquah 2 or 3 miles a bold rocky coast, with high steep hills covered with timber, runs straight for about 8 miles, changing to low sandy beach with sand dunes, backed by a high ridge of hills. This continues for 15 miles, when the hills stretch out to the shore, and crowd upon to end abruptly in steep bluffs forming Cape Perpetua, which is 39 miles N. by W. ½ W. from Umpquah light, with an approximate geographical position of latitude 44° 19′, longitude 124° 06′. The face of the cape is nearly 5 miles long, with very slight projection from the straight trend of the shore. It is very high, and has a regular although steep descent to the shore, bringing the trees to its very edge.

From the Umpquah to Perpetua, at a distance of a mile from the shore, soundings are laid down from 8 to 14 fathoms.

This cape was named by Cook in 1778, and by bearings placed in latitude 44° 06′. Vancouver, in 1792, gave its position in latitude 44° 12′.

In recent maps we find a small stream opening south of Cape Perpetua, called the Sciisteum river. We could not detect it in 1853 from the distance of a mile, but believe there is a creek, with the name of Scius-clan, in this locality.

To the northward of Perpetua the coast range of hills is cut by numerous valleys, through which flow many small streams to the ocean.

YAQUINNAH RIVER.

Nine miles north of Perpetua is the mouth of a stream believed to be the Yaquinnah. It is said to expand into a bay, 3 miles long by 1½ wide, running nearly east, and very much contracted at the middle, where a small islet exists. The south head to the entrance is formed by a spur of the hills from Perpetua. The north point has likewise a bold head with a low sand spit stretching south half a mile. The entrance is in latitude 44° 27′ north, (approximate.)

Recent maps place the Alciyco river about this latitude. No name is given in the last Coast Survey reconnaissance, and it was not seen at all by McArthur in 1850.

The names of the streams hence to the northward are very conflicting, and will continue so until a land exploration is made along the seaboard for determining their peculiarities and the latitudes of their mouths.

CELETSE RIVER.

North of Perpetua the shore continues straight, high and bold for 5 miles, when a cluster of rocks occur, and the bluff changes to low sand beach, running nearly to the mouth of a small stream, about 5 miles south of Cape Foulweather, called the Alseya on the Coast Survey reconnaissance of 1850, and the Celetse in 1853. This name is the proper one. The north head, which is bold, has a rock close under it. Thence the shore is low and sandy to Foulweather.

CAPE FOULWEATHER.

From Perpetua to this cape the soundings range from 7 to 12 fathoms about a mile from shore. The cape is in latitude 44° 45′ north, and longitude 124° 04′ west, and forms a high, bold headland, half a mile in width, jutting out about half a mile from the low beach and backed by high mountains. It is covered with wood, and has several small rocks on its southwest face, with one rocky islet a mile from it. To the northward of the cape are three rocky islets standing a short distance from the low beach, and readily distinguished by being projected against it. In August, 1853, the astronomical party of the survey was very desirous of effecting a landing on or near this cape, but the sea was rolling in too heavily to warrant the attempt. There was no appearance of a landing being at all feasible except in remarkably quiet weather.

This cape was named by Cook on the day he made the coast, March 6, 1778, but the point of the headland, so called on the Coast Survey reconnaissance of 1853, is not that referred to by him. At noon he was in latitude 44° 33′, and the land extended from NE. ½ N. to SE. by S. about 8 leagues distant. In this situation he had 73 fathoms over a muddy bottom, and 90 fathoms a league further off shore. The land he describes of moderate height, diversified by hills and valleys, and principally covered with wood. No striking object presenting itself except a high hill with a flat summit, which bore east from him at noon. This must have been what he subsequently called Cape Perpetua. At the northern extreme the land formed a point, which he named Cape Foulweather, from the exceeding bad weather he met with soon after. The expression "northern extreme" has led some geographers to place the cape as high as latitude 45½°, but he judged the Foulweather he named to be in 44° 55′. Being here driven off the coast by continued bad weather he had no opportunity to verify his position, and did not sight the land again until in latitude 47° 05′; thus passing by the entrance to the Columbia. Vancouver places it in latitude 44° 49′. Both of these determinations evidently refer to the northern part of the high land.

Nekas river.—Soon after passing Foulweather the shore becomes abrupt and moderately high, with an increased depth of water immediately off it. Four miles south of the Nekas, which is in latitude 44° 56′, it changes to low sand dunes stretching into a narrow point, forming the south point of the stream, while the north point is a low bluff. The entrance is very narrow and shoal, and inside the river is reported to spread out into a bay of about a mile in extent, and receiving the waters of a stream draining a valley coming from the eastward.

The name is that used on the Coast Survey charts of 1850 and 1853. Previous maps have a small stream emptying near this, called the Cowes river.

From the Nekas to Cape Lookout the distance is 24 miles, and course N. by W. ½ W., with a shore-line broken by several small streams, amongst which are the *Nechesne* (reconnaissance, 1853,) in latitude 45° 02′, with rocks in the entrance; the *Nestuggah* (reconnaissance, 1853,) in latitude 45° 06′, called Vaquinna in reconnaissance of 1850, and having a large rock off its mouth; the *Nawuggah* (reconnaissance, 1853,) in latitude 45° 14′, and on the south side of whose entrance is a single rocky islet, hereafter referred to.

CAPE LOOKOUT.

The soundings from Foulweather to this cape show from 13 to 31 fathoms of water at a distance of a mile from the shore, increasing from 18 fathoms north of latitude 45° N.

This cape is situated in latitude 45° 20′, longitude 124° 00′. It projects somewhat sharply into the sea for half a mile, and as seen from the south the top is tolerably flat and regular, and at the highest part we judge it to attain an elevation of 3,000 feet. The face directly toward the ocean is perpendicular, high, and toward the south destitute of trees. About 8 miles southward of it is a large single rock off the Nawuggah, estimated to be 250 feet high, and standing well out from the low sand beach behind it. No rocks lie off this cape, but one appears very close in shore about a mile to the northward of it.

This name is that used on the Coast Survey charts of 1850 and 1853, and is intended to apply to the cape mentioned and fully described in July, 1778, by Meares, whose description has been corroborated by Vancouver and incidentally by ourselves.

For January, 1859, the line of equal magnetic variation of 20° east crosses the coast-line in latitude 45° 23′, and in latitude 45° 13′ crosses the 125° of longitude. This line annually moves about 1 mile southward.

CAPE MEARES.

Two or three miles after leaving Cape Lookout the land falls to a low sand beach, behind which is a long lagoon, called the Nat-a-hats, stretching northward, and having an opening under the south head of the well marked Point North, which is the termination of a spur or ridge running from the southeastward, presenting an abrupt front to the ocean for about two miles, and being part of the western boundary of Tillamook bay. In coming down this coast in the fall of 1857 we made a few notes upon some objects, and find the following memorandum made whilst near this point: "three high rocks (one arch) off point south of False Tillamook; one more on the north side." Not being then aware of any doubt as to the name of the cape, no other particulars were noted. Four rocks are laid down off the southwest face on the Coast Survey reconnaissance of 1850, and one on the north. Three large rocks and one small one are laid down off the southwest face in the original sheets of the reconnaissance of 1853, the most distant being one mile from shore, with several small ones between them and the shore; and two or three others off the northwest face.

In 1775 Heceta placed La Mesa, the Table, in latitude 45° 28′—a flat-topped mountain, seen at a great distance.

In July, 1788, Meares, in the Felice, after passing False Tillamook, says: "The distant southerly headland we called Cape Lookout. This cape is very high and bluff, and terminates abruptly in the sea. At about the distance of two miles from it there rose three large rocks, which are very remarkable for the great resemblance they bear each other. The middle one has an archway, perforated, as it were, in its centre, through which we plainly discovered the distant sea. They more particularly attracted our notice as we had not observed between King George's sound and this place any rocks so conspicuously situated near the land; their distance from each other might be one-quarter of a mile, and we gave them the name of the 'Three Brothers.' By eight in the evening we were within 3 or 4 leagues of Cape Lookout, which we judged to lie in latitude 45° 30′ north, longitude 235° 50′ east.''

In 1792 Vancouver described it as a small projecting point, yet remarkable for the four rocks which lie off it, one of which is perforated as described by Meares. He places it in latitude 45° 32′.

This cape is very frequently, but erroneously, stated to be the "Clarke's Point of View," as described by Clarke in the winter of 1805–'6.

In the Coast Survey reconnaissance of 1853 the northern part of this cape is placed in latitude 45° 30′, longitude 123° 58′, and stretching southward two miles to the cluster of rocks above described.

TILLAMOOK BAY.

On the Coast Survey reconnaissance of 1853 the entrance to this bay is placed in latitude 45° 34′, four miles north of Cape Meares. The southern point is low and the termination of a spur from the crest of the cape, whilst the north head is high and bluff. The entrance is very narrow, and reported to have very little water upon the bar; inside it expands into a long wide bay, stretching to the S.SE. behind Cape Meares. No survey has yet been made of it, and some doubts are expressed about the enlarging of the river to form a bay. Two miles northward of the northern head stands a couple of large rocks; thence the coast runs nearly straight to False Tillamook, receiving a considerable stream, called the *Nehalem*, in latitude 45° 41′. Clarke, when about five miles south of Tillamook Head, says that "the principal town of the Killamucks is situated 20 miles lower (south) at the entrance to a creek called Nielee, expanding into a bay, which he named Killamucks bay. Upon this bay were several Killamuck towns. Killamuck river is at the head of the bay, 100 yards wide, and very rapid; but having no perpendicular fall, is a great avenue for trade. There are two small villages of Killamucks settled above its mouth, and the whole trading portion of the tribe ascend it till by a short portage they carry their canoes to the Columbia valley, and descend the Multnomah to Wappatoo island.'' This information he obtained from Indians and traders. On this short expedition he made all his distances from Cape Disappointment and Point Adams too great, and reducing the forementioned 20 miles by the proper proportion, it would give us 13 miles as about the position of the Nehalem. His name seems to agree with this, but the description applies to what is generally known as Tillamook bay.

The shore about the Nehalem is low and sandy, with sand dunes backed by high wooded hills, and cut up by many valleys. It was here that Meares stood in for an anchorage (July 1788) until he found bottom in 10 fathoms, but hauled out again and named the place Quicksand bay, and the adjoining headland north, Cape Grenville.

CAPE FALCON OR FALSE TILLAMOOK.

The northern part of this headland lies in latitude 45° 47′. Longitude 123° 58′. Upon passing close by it in 1857, we judged it to be not less than 3,000 feet high, with the sea-face coming precipitously to the ocean; and off it are lying two prominent rocky islets. As seen from the southward the top is irregular, whilst the hills in shore fall away. Like some other points in this latitude, the southern face of the cape is destitute of trees, but covered with a thick growth of grass, bushes and fern. Two miles south of it is a stretch of sand beach and sand dunes.

From Cape Lookout to this headland a depth of 20 fathoms may generally be found a mile from shore, but, as upon the whole coast, a heavy regular swell always rolls in from the west.

In 1775 Heceta placed a headland in latitude 45° 43′, to which he gave the appellation Cape Falcon. According to his description it had a rocky islet lying off it. This name would be far better than applying the term "false" to capes, bays, &c., of the names of which we were not at first certain.

In 1788 Meares called this Cape Grenville.

The Indian name for the head is Ne-a-kah-nie.

TILLAMOOK HEAD.

This prominent cape, in latitude 45° 58′, is 12 miles N.NW. from Cape Falcon, and 19 miles SE. by S. ½ S. from Cape Disappointment. The coast from Cape Falcon curves two miles eastward; is bold and rugged, guarded by many high rocky islets and reefs; and in several places bordered by a low sand beach at the base of the cliffs. Two miles south of the head, Clarke (1805–'6) locates a creek 80 yards wide at its mouth, which he calls Ecola, or whale creek. From the south bar of the Columbia river the summit of Tillamook appears flat for some distance back, and has an estimated height of 2,500 feet. Off the face of the cape, which is very steep, lie several rocky islets; one of them is high and rugged, and stands out about a mile from the southwest face. Around it the water is believed to be deep, as we have seen a steamer come almost upon it in a thick fog; but inside of it lie several high rocks. From the bar two rocks can be distinctly seen, the inner being the larger, and its apparent distance from the head about half the apparent height of the cape. Whether the smaller is the one off Cape Falcon we did not determine. As seen from the southward the large rock has a perpendicular face to the westward, and slopes to the east. It is the resort of thousands of seals.

This cape is a good landmark for making the mouth of the Columbia river, no such high headland occurring on the coast northward of it for over 70 miles; and before being up with it the moderately high land of Cape Disappointment is seen and made as two islands.

The face of the cape is much broken and formed principally of yellow clay, presenting a bright appearance in the sunlight. Clarke says that 1,200 feet above the ocean occurs a stratum of white earth, then (1805–'6) used by the Indians as paint; and that the hill sides slip away in masses of 50 to 100 acres at a time.

Upon the top of the cape Clarke says he found good, sound solid trees growing to a height of 210 feet, and acquiring a diameter from 8 to 12 feet.

From Tillamook head southward many miles was the country of the Killamuck Indians, then estimated to number 1,000 people, and having 50 houses.

This is the head which is properly called "Clarke's point of View."

The coast from Point Orford to Tillamook Head is well diversified by high hills and valleys, presenting a country well watered by numerous small streams emptying into the ocean. It is densely covered with various woods, and for a few miles inland looks favorably from the deck of a vessel. Some distance in the interior ranges of mountains occur, the general direction of which appears to be parallel with the coast line, which attained its greatest elevation and compactness between Cape Falcon and Tillamook Head; after which a sudden and marked change takes place, and a stretch of low sandy coast commences and runs for nearly 100 miles northward, only broken by Cape Disappointment.

COLUMBIA RIVER.

POINT ADAMS.

Two miles northward of Tillamook Head commences a peculiar line of low sandy ridges, running parallel to the beach towards Point Adams, and appearing like huge sand waves covered with grass and fern. Between some of them run small creeks, whilst behind the country is low, swampy and covered with wood and an almost impenetrable undergrowth. About three miles north of the head, Clarke says, a beautiful stream empties with a strong rapid current; it is 85 yards wide, and has 3 feet at its shallowest crossing.

Point Adams is low and sandy, covered with bushes and trees to the line of sand beach and low dunes; and although it is reported to have washed away over half a mile since 1841, we find comparatively small changes since the survey of Broughton in 1792.

The geographical position of the triangulation station of the Coast Survey on the point is:

	° ′ ″	
Latitude	46 12 30.4	north.
Longitude	123 56 55.8	west.
	h. m. s.	
Or, in time	8 15 47.7	

This station is on the inside of the point, and almost half a mile from it.

No light-house exists here, but the necessity for one has been so repeatedly urged that we cannot refrain from calling attention to a few facts bearing upon the question. Off this point, SW. by S. 3¼ miles, lies (1852) the bar of the south channel, through which the far greater portion of the trade has passed; and all vessels use this point as a standard point for their ranges. During the early part of the evening dense fogs, formed over the waters of Gray's and Shoalwater bays, are brought southward by the summer winds, and roll over Disappointment, which they completely shut in before reaching across the river, so that a vessel might make a light on Point Adams when the other cape was invisible; but by seeing both lights a vessel could hold any required position at night near either bar, and run in or take a pilot upon the first opportunity; for it would be assuming too great a risk to enter the river at night, or without a pilot.

This point was called Cape Frondoso by Heceta, who discovered, but did not enter, this river in August, 1775, and named Adams' Point by Captain Gray, in 1792. The Indian name of the point is Klaât-sop.

The beach around Point Adams and to the southward some distance is usually called Clatsop beach. Upon it, many years ago, before the whites occupied the country, a Chinese or Japanese junk, with many hands and a cargo of beeswax, was cast ashore and went to pieces; but the crew were saved. In support of this Indian tradition, there are occasionally, after great storms, pieces of this wax thrown ashore, coated with sand and bleached nearly white. Formerly a great deal was found, but now it is rarely met with. Belcher mentions having a specimen. Many people on the Columbia possess them, and we have seen several pieces. In a late work this wreck has been confounded with another that took place near Cape Flattery.

COAST AND SHORES OF WASHINGTON TERRITORY AND OPPOSITE SHORE OF VANCOUVER ISLAND.

CAPE DISAPPOINTMENT.

The north side of the Columbia river forms part of Washington Territory.

This cape is the only headland from Tillamook to latitude 47° 20′ that breaks the low line of shore. It presents a geological formation not before met with on the seaboard, being composed of horizontal columnar basalt, rising to an elevation of 287 feet, disposed in a succession of huge round hills, broken on the sea front by short strips of sand beach, and covering an irregular area of about three miles by one. The sea-faces of all the hills and irregularly projecting knobs rise perpendicularly for many feet, then slope slightly inshore to narrow ridges; are destitute of trees, but covered with grass, fern, and bushes, and have an excellent though thin soil. Inland of their crests the trees commence, and their tops reaching above the summits of the hills increase their apparent height. The inshore slope of the hills is more gentle, so that paths can be easily carried to their tops. In 1851 we opened an ox-team road to the summit of the cape. When the evening fogs from the northern bays do not cover the cape, we have sometimes experienced a dense fog rolling down the river about sunrise, enveloping everything below the top of the cape upon which we have stood, when it looked like an island less than a hundred yards in extent, and surrounded by the river fog, that must be felt to be appreciated. We were 35 days on this cape before obtaining a single night's observations.

As seen from the southward, when off Tillamook Head, Cape Disappointment is made as two round-topped islands; approached from the northwest it rises in a similar manner; from the west and southwest it appears projected upon the mountains inland, but the slightest haziness in the atmosphere brings it out in sharp relief.

This cape being basaltic, and showing an almost iron front to the river and sea, it is improbable that, "in the memory of many, Cape Disappointment has been worn away some hundred feet by the sea and strong currents that run by it."

On the first landing beach on the inside of the cape we found a deposit of auriferous and ferruginous "black sand," the flakes of gold being very small and scarce. This ferruginous deposit—the "black sand" of the California gold digger—caused a local disturbance in the magnetic variation, amounting to 26′.2, being that quantity less than the declination found upon the summit of the cape.

CAPE DISAPPOINTMENT LIGHT-HOUSE.

The light-house is not upon the top of the cape, but upon a spur a little to the west of the southeast point, and about 95 feet below the highest part. The tower is whitewashed, placed 192 feet above the level of the sea, and being 40 feet in height and projected against a dark green background shows well in daylight.

The light is a *fixed white light*, of the first order of Fresnel; was first exhibited October 15, 1856, and shows from sunset to sunrise. Under a favorable state of the atmosphere it should be seen from a height of—

10 feet	at a	distance of	21	miles.
20	"	"	22½	"
30	"	"	23¾	"
60	"	"	26⅓	"

Its geographical position, as determined by the Coast Survey, is:

	° ′ ″	
Latitude	46 16 32.7	north.
Longitude	124 02 13	west.
	h. m. s.	
Or, in time	8 16 08.9	

Magnetic variation 20° 45′ east, in July, 1851, with a yearly increase of 1′.4.

Counting round seaward from the south, it commands a horizon of about 135 degrees, that is, from S.SE. to W.NW.; so that vessels coming from the northward cannot see the light until nearly in the latitude of the river. Placed on the top of the cape, it could have been easily made to show over the northwest part of it, and would also have commanded the entire river and Baker's bay.

From Cape Disappointment we have the following bearings and distances of objects to the northward:

Point Grenville	NW. by N. $\frac{1}{2}$ N.,	62 miles.
Destruction island	NW. by N.,	84 "
Flattery rocks	NW. $\frac{5}{8}$ N.,	118 "

The last line passes tangent to the coast in latitude 47° 58′, where there are two well marked rocks, which will be hereafter described.

Fog-bell at Cape Disappointment.

A fog-bell of 1,600 pounds has been placed on the bluff in advance of the light-tower, and will be sounded during foggy or other thick weather night and day. The distinctive mode of striking we have not yet found published. The machinery is on a level with the ground, in a frame building, whitewashed, and with the front open to receive the bell.

The primary astronomical station of the Coast Survey is on the highest part of the southern extremity of the cape. Its geographical position is:

	° ′ ″	
Latitude	46 16 35.2	north.
Longitude	124 02 01	west.
	h. m. s.	
Or, in time	8 16 08.1	

From Cape Blanco to Cape Disappointment the extent of ocean shore line is not less than 285 miles.

In August, 1775, this cape was placed by Heceta in latitude 46° 17′, and called Cape San Roque.

In July, 1788, it was called Cape Disappointment by Meares, and placed in latitude 46° 10′ "by an indifferent observation." It was called Cape Hancock by Gray, in 1792, and the entrance placed in latitude 46° 17′; he, however, changed this name to Disappointment upon hearing that Meares had so named it.

In 1792 it was placed in latitude 46° 19′ by Vancouver.

On the Pacific coast it is and has been known by no other name than Cape Disappointment. The Indian name for the cape is Kâh-eese.

THE ENTRANCE TO THE COLUMBIA RIVER.

The entrance to this, the great river of the Pacific coast, is 5 miles wide between the nearest parts of Cape Disappointment and Point Adams, bearing S. 58$\frac{1}{2}$° E. and N. 58$\frac{1}{2}$° W. from each other; but the passage is badly obstructed by shifting shoals that lie 2 or 3 miles outside of the line joining the points. The numerous surveys that have been made of this river prove so conclusively the great changes which the channels through the shoals undergo that we shall not attempt to give any directions concerning the present north and south channels. The best advice we can offer is, when up with the bar, *wait for a pilot.* The mail and coasting steamers enter the south channel (October, 1857,) parallel and close to the beach south of Point Adams, but with a heavy swell from the westward they roll very much after rounding the point. In heavy weather some of them prefer entering the north channel, although it gives a detour of some miles, but the bar has, and always has had, more water upon it than that at the south channel, and does not change its position as much, from the unwearing nature of the cape. Sailing vessels cannot beat into the south channel against the summer winds blowing from the northwest, but almost invariably come out through it. The heavily laden vessels of the Hudson Bay Company have always used the north channel.

During heavy weather, and especially in winter, the sea breaks with terrific fury from northwest of Cape Disappointment well to the southward of Point Adams; and we remember the mail steamer trying for 60 hours to find the smallest show of an opening to get in. Sailing vessels have laid off the entrance 6 weeks, waiting for a fair opportunity to enter, and many lie inside for weeks trying to get out. The mail steamer, meanwhile exerting all her power, would drive through the combers, having her deck swept fore and aft by every sea. Few places present a scene of more wildness than this bar during a southeast gale, contrasting strongly with many times during the summer, when not a breaker is seen to mark the outline of the shoalest spot. From the summit of Cape Disappointment we have often watched the bar in varied states of wind and weather, and crossed it when calm and breaking. What is most needed here is a powerful propeller tug, which the amount of trade would assuredly warrant, when we know that the much smaller trade of Humboldt bay supports handsomely a tug for that bar. In bad weather the pilot boats cannot venture out, but a steamer might; and the mail steamers, to avoid delay, now regularly carry a bar pilot with them.

During the season of freshets, about June, the pilots say that the river brings down such a vast body of water that they can frequently take up for use fresh water upon the bar.

When off the entrance in fine, clear weather, the beautiful snow peak of Mount St. Helens* shows over the lowest part of the land inside, and apparently in the middle of the river valley. It is very regular in outline, and presents a pyramidal appearance, having a base equal to either side. It is over 75 miles eastward from the entrance to the river, and attains an estimated elevation of 12,000 feet. It is volcanic, and occasionally discharges volumes of smoke.

On October 22, 1792, Vancouver reported having seen several water spouts off the entrance, and that some of them passed quite near his ships.

The current.—In October, 1851, whilst lying at anchor in the south channel off Sandy island, we measured the strength of the ebb current, and found it to be nearly $5\frac{1}{2}$ miles per hour.

Tides.—At Astoria the corrected establishment or mean interval between the time of the moon's transit and the time of high water is XII*h.* XLII*m.* The mean rise and fall of tides is 6.1 feet; of spring tides, 7.4 feet; and of neap tides, 4.6 feet. The mean duration of the flood is 6*h.* 3*m.*; of the ebb, 6*h.* 28*m.*; and of the stand, 0*h.* 33*m.* The average difference between the corrected establishments of the a. m. and p. m. tides of the same day is 1*h.* 02*m.* for high water and 0*h.* 52*m.* for low water. The differences when the moon's declination is greatest

* Named by Vancouver in 1792.

are 1*h.* 38*m.* and 1*h.* 15*m.* respectively. The average difference in height of those two tides is 1.4 foot for the high waters and 2.3 feet for the low waters. When the moon's declination is greatest those differences are 1.9 foot and 3.7 feet respectively. The average difference of the highest high and lowest low waters of the same day is 7.9 feet, and when the moon's declination is greatest, 8.9 feet. The highest high tide in the twenty-four hours occurs about 12*h.* 11*m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about 0*h.* 15*m.* before, when south. The lowest of the low waters occurs about 7½ hours after the highest high water. At Cape Disappointment it is high or low water about 40*m.* earlier than at Astoria.

The discovery of the river and changes in the channel.—The discoverer of this river was Bruno Heceta, commanding the Spanish ship Santiago. On the 15th of August, 1775, he was off the entrance of a great river or inlet, which he called Enseñada de Asuncion, (Assumption inlet;) but in the charts afterwards published in Mexico it was denominated Enseñada de Heceta and the Rio de San Roque.

In July, 1788, Meares sought an anchorage under Cape San Roque, and finding the breakers barring his progress, applied the name Deception bay to the mouth of the river; and, doubtless to vent his pique upon the Spaniards for the ill treatment he had received at their hands, wrote: "We can now safely assert that there is no such stream as that of Saint Roc existing, as laid down in the Spanish charts; to those of Maurello we made continual references, but without receiving any information or assistance from them."

In April, 1792, Vancouver sought for this river, but finding a great line of breakers before him, very wisely did not attempt to pass through them. On the 29th of that month he spoke the Columbia of Boston, commanded by Captain Gray, who informed him that he had laid off the mouth of a river in latitude 46° 10′, where the outset or reflux was so strong that for nine days he was prevented from entering; whereas Vancouver, having passed this position on the 27th, wrote on that day "that if any inlet or river should be found, it must be a very intricate one, and inaccessible to vessels of our burden, owing to the reefs and broken water."

On the 11th of May, 1792, about noon, Captain Gray's log states, that "being a little to the windward of the entrance into the harbor, bore away and run in E.NE. between the breakers, having from 5 to 7 fathoms water. When we came over the bar we found this to be a large river of fresh water, up which we steered." Without knowing of any reliable chart by him, we are of opinion that then there was but one channel, and that to the north of what is now Sandy island. He evidently came upon the entrance after very favorable weather, because he not only passed over the bar between the breakers with all sail set, but had only made 6 leagues between daylight and noon. He remained 8 or 9 days in the river, made a rough sketch as far as Tongue Point or Gray's bay, and named the river after his ship, calling it the "Columbia's river."

In October, 1792, Vancouver tried to enter the river with the Discovery, but failing, on account of the bad state of the bar, he ordered Lieut. Broughton, in the armed tender Chatham, to enter, which he did three days afterwards, and then commenced a survey of the river, carrying it forward in boats to Point Vancouver, in latitude 45° 27′, and returning to his vessel in ten days. He considered the widest part of the river for 25 miles as an inlet. This is the first reliable survey we have of the river. Gray's eye sketch, which extended to about Gray's bay, showed 36 miles from Cape Disappointment, whereas it is only 16, following the course of the northern channel by the most recent surveys. After crossing the bar the Chatham anchored in 4 fathoms, $1\frac{1}{4}$ mile E. by S. $\frac{3}{4}$ S. from the eastern part of Cape Disappointment. Within a cable's length of the ship the sea broke very heavily on the western end of a shoal called the Spit Bank, the southern edge of which stretched about E. by N. in a direct line to *Chinook Point*,* behind which rises *Scarborough hill*† destitute of trees and covered with fern. Well up in *Baker's bay*,‡ north of the cape, he gives soundings in 3, 5, and 7 fathoms within less than a mile from the shore. From Cape Disappointment the southern edge of an outside shoal extended about $1\frac{1}{2}$ mile SW. by S., stretched W.SW. nearly 2 miles, then trended N.NW. parallel to the outer beach. A great shoal occupied the whole middle part of the river east of Point Adams. Its northern edge ran parallel with and half a mile from the shore between Gray's Point and Ellis' Point,§ there being from 7 to 14 fathoms in the channel between it and the shore. From Ellis' Point it then stretched in nearly a straight line to within a mile of Point Adams, where the tail of it had but 2 fathoms; thence curved to the SE. about a mile, and stretched in a long curve to *Tongue Point*,‖ keeping about three-quarters of a mile from the shore abreast of Point George, 5 miles from Point Adams; and in the channel between it and the shore he gives from 3 to 7 fathoms. Starting half a mile inside of Point Adams and stretching over to the tail of the above shoal was a bar, having but 3 fathoms upon it.

From Point Adams the northern edge of the breakers stretched seaward, first, W. $\frac{1}{2}$ N. about $3\frac{3}{4}$ miles; next, SW. by W. $\frac{1}{2}$ W. about 5 miles; then took a rounding course to the southward, extending along the coast at a distance of nearly 8 miles. From this point of view (Adams) the north and south breakers were so shut in with each other as to present an entire line of heavy broken water across the channel, which was about $1\frac{1}{2}$ mile wide at the narrowest part, and having not less in any place than 4 fathoms. The outer line of 5 fathoms off the bar bore SW. by W. $5\frac{1}{4}$ miles from Cape Disappointment.

This channel permitted the heavy western swell to roll in over the bar, and break upon the shoal stretching between Point Adams and Point Ellis. The directions given by Broughton for entering are: to bring Tongue Point, which looks like an island near the southern shore of the river, to bear about E. by N. and then steer for it; crossing the bar in 4 and 5 fathoms.

In stating the distances above, we should mention that Broughton gives the course from Disappointment to Adams as SE. by E. and the distance about 4 miles, whereas it is really 5 miles. Making this change in his base, and all other positions in proportion, we find that Tongue Point comes within half a mile of the determination by the triangulation of the survey; proving Broughton's work right but the base wrong.

From the foregoing description we deduce the following facts: That but one channel existed at the entrance to the Columbia river in 1792; its general direction across the bar was E. by N. $\frac{3}{4}$ N. passing $1\frac{1}{2}$ mile south of Cape Disappointment; it was 6 miles long from the outer 5 fathoms curve to a line joining Point Adams and the cape; it was $1\frac{1}{2}$ mile wide, and having not less than 4 fathoms in it: That the Spit bank stretched nearly straight from about a mile

* Its present name, but called Village Point by Broughton, because he here found a large deserted village. He says the natives called it Chenoke.

† Named after an employé of the Hudson Bay Company, who lived here and acted as pilot on the river at and since the time of the United States Exploring Expedition.

‡ Named by Broughton after Mr. James Baker, commanding the schooner Jenny, of Bristol, which he found at anchor here upon entering.

§ So named on Belcher's survey of 1839; subsequent surveys call it Point Ellice.

‖ So named by Broughton.

east of the Cape to Chinook Point. In the space bounded by the 3 lines joining cape Disappointment, Chinook Point, and Point Adams, 5 fathoms water was the least found. The deepest channel after getting in was close under the north side of the river eastward of Chinook Point, and that, between the river side of Point Adams and the shoal stretching from Gray's Point towards it, a narrow channel existed with 3 fathoms in it.

Broughton says: "The discovery of this river, we were given to understand, is claimed by the Spaniards, who call it Entrado de Ceta, after the commander of the vessel, who is said to be its first discoverer, but who never entered it; he places it in 46°."

After completing the survey he could not get out for several days, and the Jenny had been unable to cross the bar, during the entire time he was up the river.

In 1813, when the English sloop-of-war Raccoon arrived in the Columbia she found the shoals off the entrance had considerably changed in extent and position from the time of Broughton.

British Admiralty Survey in 1839.—In 1839 the entrance was surveyed by Sir Edward Belcher, in the Sulphur, and remarkable changes had taken place. Between Cape Disappointment and Point Adams a large middle bank had formed, and near its eastern extremity a sandy island, with a bank 1½ mile in extent, visible at low water and full of snags and trees. Its northwestern point bore E.SE. 2¾ miles from Cape Disappointment, stretching on this course 1½ mile further, so that its eastern extremity, off which was deep water, bore N. ½ W. 1½ mile from Point Adams. This island and the bank naturally divided the waters of the river, the greater volume running to the northward of the bank, through *Belcher's* channel, with 7 fathoms in it, and being a mile wide within the limits of the 3-fathom curves until it approached the cape, where it was contracted to less than half a mile on a line E.SE. from the cape, but having increased its depth to 16 fathoms. This channel had cut away the western end of Spit bank as laid down by Broughton. From the cape, which it washed, this channel ran south for 2¼ miles with an average depth of 7 fathoms, and being a mile wide within the 3-fathom curves; then it ran SW. ½ W. for 2¼ miles to the bar, expanding in width and decreasing in depth, but in no place giving less than 4½ fathoms upon the bar, which bore S.SW. from the cape, distant 4 miles, and from Point Adams W. ¾ S., distant 6 miles. In the northern angle, where the channel made the east turn, he has laid down a spot bare at low water with 7 fathoms close under it. From the cape it bears S. by W. 2¼ miles.

The main channel eastward of Sandy island was under Chinook and Ellis Points, having deep water off them, but becoming shoaler and intricate beyond them.

Between this channel and the south shores lay the great shoal existing in 1792, not very much changed in features, with a narrow channel running from Point Adams to Tongue Point, having from 4½ to 9 fathoms.

The west end of this shoal stretched out to the line joining Chinook Point with Point Adams, about a mile from the latter, whilst between the tail of Sandy island and this shoal was a channel half a mile wide, and having from 3½ to 4½ fathoms. Between Sandy island and Point Adams ran Queen's channel*, contracting to half a mile wide within the 3-fathom curves, one mile from Point Adams, gradually expanding and running in a general direction W. by S. for 3¼ miles, when it divided into two—one running into the north channel through a narrow 4-fathom cut, and the other continuing south, forming a *south channel* one-third of a mile wide, and having 3¼ and 3½ fathoms upon it. From Cape Disappointment it bore S. ½ E., distant 4 miles, and from Point Adams W. by S. ½ S., 4 miles. Between the two bars, about 2 miles apart, lay

* Named by Belcher in 1839.

an irregular shoal of small extent, having $2\frac{1}{2}$ fathoms upon it. The joining of the north and Queen's channels enabled a vessel to have a 4-fathom channel south of Sandy island, with a leading wind in summer time, while the north was a beating channel.

A spot, bare at low water, existed $1\frac{1}{4}$ mile from Point Adams; its northern extremity close to Queen's channel, and bearing west from Point Adams. It stretched south half a mile, and was nearly a quarter of a mile in width.

It may not be out of place here to note that the channel on the south side of the river, east of Tongue Point, now known as the *Woody Island channel*, and claimed as a recent discovery, is clearly indicated by the soundings of Belcher.

By a comparison with the partial survey of 1792 very remarkable changes will be seen to have taken place. The first is the formation of the great *Middle Bank**, covering an extent of 4 square miles within the three-fathom curves, and part formed into an island occupying the track which Broughton, and doubtless Gray and Baker, sailed over with five fathoms; the formation of two channels: the bank on the SW. face of Cape Disappointment, stretching $1\frac{1}{2}$ mile southward of its old limit, and almost crossing the only channel of 1792; the existence of the Middle Bank, within half a mile of the cape, and having but one fathom upon its northwest point, where the Sulphur grounded, when Broughton states that he anchored $1\frac{1}{4}$ mile E. by S. $\frac{3}{4}$ S. from the inner part of the cape, there being deep water between him and the cape, whilst the Spit bank, which was within a cable's length of his anchorage, and stretching to Chinook Point, had been cut away by the broad Belcher channel; the cutting away of three miles of the western part of the shoal off Point Adams, and the opening of the channel along the Clatsop beach and south shore, past Point St. George and Tongue Point.

Belcher calls the bank S.SW. of the cape the Spit bank; and where Broughton's Spit bank joins Chinook Point, he designates it Chehalis spit.

In his narrative he remarks that "the shoals in the entrance to this river have most materially changed their features within the last two years."—(Vol. 1, p. 288.)

Survey of the United States Exploring Expedition, 1841.—In this survey we find but one opening to the ocean with the north and south channels passing through it. The bar had 5 fathoms upon it, and was nearly two square miles in extent, the water deepening and the channel contracting after passing it.

From Cape Disappointment the bar bore SW. by S. $\frac{3}{4}$ S., distant $4\frac{1}{4}$ miles; from Point Adams W. by S., distant $6\frac{1}{4}$ miles; with the north shoal stretching south $2\frac{1}{2}$ miles from the cape, and the great south shoal nearly W.SW., 5 miles from Point Adams, having at the narrowest part of the single entrance a breadth of a mile.

From the bar the course in for the north channel was E.NE. $2\frac{1}{2}$ miles; then N. $\frac{1}{2}$ W. $3\frac{1}{4}$ miles to the inside of Cape Disappointment, after passing which the channel was wide, regular, and deep for 4 miles, about E.SE., passing close by the north side of Sandy island.

From the bar the course for the south channel was E. by N. $\frac{1}{2}$ N. for $6\frac{1}{4}$ miles, running within three-quarters of a mile of Point Adams; thence along the Clatsop beach in a good, wide channel.

The Middle Bank was nearly triangular, with one point abreast of Cape Disappointment; the second $1\frac{1}{4}$ mile north of Point Adams; and the third at the meeting of the channels inside the bar. Each side was three miles long; Sandy island was then composed of two, the eastern end of the larger and southern one bearing N.NW. $1\frac{1}{4}$ mile from Point Adams.

* Named by Belcher in 1839.

The western tail of the great middle shoal, east of Point Adams, bore from that point about N.NE., a little over a mile distant, and in range to Chinook Point.

The reduced map of the survey of the United States Exploring Expedition, on an English chart, shows the distance from Cape Disappointment to Point Adams as only $4\frac{1}{2}$ miles, with the bearing SE. by E. $\frac{1}{2}$ E. Our measurements above are made upon a scale representing that distance as almost 5 miles, according to a recent triangulation.

The changes that had taken place since Belcher's survey, 2 years previous, were: that the south sands had stretched westward over the entrance of Queen's or south channel; and that channel had joined with the north and emptied over one bar, which was almost identical in position and extent with the survey of 1839. It had, however, moved about a third of a mile to the southward.

The north channel was, therefore, little changed; its general direction was the same; it had at least a fathom more than the south channel, and retained the same shape and direction after passing inside the cape.

The contour and position of the Middle Bank was nearly the same, but its eastern point had moved nearly half a mile to the NW., giving deep water where Belcher placed the eastern part of Sandy island, whilst the western islet occupied nearly the same position as formerly.

The western extremity of the great middle shoal, east of Point Adams, was hardly changed.

The course in over the bar, and through Queen's or the south channel, was straight for over 6 miles to abreast of Point Adams, and then ran in the same direction as in 1839.

The United States sloop-of-war Peacock was lost on the north shoals, under Cape Disappointment.

SURVEY OF 1850.

This, the first examination by the Coast Survey, was undertaken under peculiar difficulties, which were successfully overcome.

In this survey we find the formation of a new south entrance, but evidently of so recent date that the bar at the entrance cannot be said to have over 16 feet upon it, although two very narrow passages on either side of the middle ground of the bar give 3 fathoms. From Point Adams this bar bore SW., distant $3\frac{3}{4}$ miles, being S.SE. $5\frac{1}{4}$ miles from Cape Disappointment light-house. Inside the entrance, within the 3-fathom curve, the width of the channel was half a mile, increasing to over a mile, and the depth of water regularly increasing to 14 fathoms off Clatsop spit, $1\frac{1}{4}$ mile from Point Adams, on a line to Cape Disappointment. The direction of the channel was straight, N. by E. $\frac{1}{2}$ E. to Sandy island, rounding Clatsop spit, and running close to and parallel with the beach east of Point Adams, with a depth of from 4 to 8 fathoms. From the outside of the bar the south edge of the south shoal stretched toward the shore, the bottom changing from hard sand to soft mud in approaching the beach.

The extent of the north bar had so much increased that it is difficult to describe, for it had an area of over two square miles, with from 4 to $5\frac{1}{2}$ fathoms upon it, and the bottom varying from hard sand to soft mud. The middle of it lay south $3\frac{3}{4}$ miles from the highest part of the cape. Within the 3-fathom curve the entrance was $1\frac{1}{3}$ mile wide, and in ordinary weather was marked by a line of breakers on either side. The course was nearly straight to the inner point of the cape, with the depth of water increasing to 11 fathoms abreast of it, where the channel was a little over a third of a mile wide, with the Sulphur spit on the east side. Passing the cape, and turning eastward and then E.SE., the 3-fathom channel was crooked, and in one place only 400 yards wide.

The two bars bore from each other SE. by E. and NW. by W., and their distance apart was $2\frac{1}{4}$ miles, with the seaward extremity of the Middle Bank in line between them.

The Middle Bank between the north and south channel was about a mile wide, and regular up to the cape, except the off-shoot to connect with Sandy island, which bore E. by S. $\frac{1}{2}$ S. $3\frac{1}{3}$ miles from Disappointment, and NW. $\frac{3}{4}$ N., two miles from Adams. N.NE. from it the Chinook shoal stretched southward within less than a mile.

The western tail of the great Middle Bank, east of Point Adams, lay NE. $\frac{3}{4}$ N. $1\frac{3}{4}$ mile from that point.

The channels north and south of this bank had changed very much, but to them we shall not again refer.

We note the following changes since the survey of 1841:

That the south sands, then stretching 6 miles westward from Point Adams, had been cut through at a point half their distance out by a wide channel, with deep water, running S. by W. from Sandy island, but the bar of this channel was not yet fairly cut through, having less than 3 fathoms upon it. This channel was therefore running at right angles to the one of 1841, and over the very spot marked bare in 1839.

That the north channel retained the same general features, but had moved to the southward; its southern part cutting away over a mile of the west end of the south sands of 1841. It still had over a fathom more water than the south channel. Inside of Cape Disappointment it retained the same general direction as in 1839 and 1841, but was more contracted.

That the Middle Bank was much changed, but its northern portion similar to that of the two previous surveys. The eastern point had moved N.NW. three-quarters of a mile since 1841. Sandy island had much increased in size, and apparently moved with it.

That a long sand bank had made out over a mile NW. from Point Adams, and was called the Clatsop spit.

That the western tail of the great Middle Bank, east of Point Adams, had been cut away three-quarters of a mile.

SURVEY OF 1852.

This was the second examination by the United States Coast Survey, founded upon a complete triangulation and the topography of Point Adams, Sandy island, and Cape Disappointment.

Two channels remained as in 1850. The south had become more defined, having $3\frac{1}{2}$ fathoms across the bar, which was three-quarters of a mile wide, and the general direction of the channel N. $\frac{1}{2}$ W. From Point Adams it bore SW. $\frac{3}{4}$ S., distant $3\frac{1}{4}$ miles, and from Cape Disappointment S. SE., $5\frac{3}{4}$ miles. It was $2\frac{1}{2}$ miles distant from the beach south of Point Adams.

The north channel was S. $\frac{1}{2}$ W., 3 miles from the cape, and W. $\frac{1}{2}$ S., $4\frac{1}{2}$ miles from Point Adams; it had $4\frac{1}{2}$ fathoms upon it toward the southern side, and its width was three-quarters of a mile. The midchannel course for $1\frac{1}{2}$ mile was NE. by N., then N. by W. towards the cape, turning to the east half a mile before reaching it, and after a mile on this course running E. SE. past the north side of Sandy island; or, continuing past the cape within a quarter of a mile, then steering E.NE. one mile, in from 8 to 5 fathoms, changing to SE. by E. through a 3-fathom channel, past the NE. side of Sandy island. The old Spit bank of 1792 had made out half a mile nearer the cape than then existing, but having a 3-fathom channel across it.

The north and south bars bore from each other SE. and NW., distant $3\frac{1}{4}$ miles apart, with the seaward face of the Middle Bank making a direct line on that course. This bank had changed its contour and was very irregular.

W.SW. of Sulphur spit a 3-fathom channel had nearly cut through the north sands. Should a channel open here it would doubtless remain a reliable one. From Cape Disappointment it bore SW. $\frac{1}{2}$ W., $1\frac{1}{2}$ mile distant.

Sandy island bore E. by S. $\frac{3}{4}$ S., 3 miles from the cape, and NW. $\frac{1}{4}$ N. 2 miles from Point Adams.

The western tail of the great Middle Bank bore NE. by N. $\frac{1}{2}$ N., a mile from Point Adams.

At the time of this survey the channels were buoyed out, but subsequent gales have displaced the buoys.

We note the following changes since the survey of 1850, a little over two years:

That the new south channel had been developed, and the bar moved three-quarters of a mile eastward, with half a fathom more water and the entrance wider.

That the north channel had contracted to half its width at the bar, with its northern line upon the line of 1850; the depth of water not quite as great, but having still a fathom more than the south bar; the channel not as straight, and the formation of a swash channel SW. of the cape across the north sands.

That the Spit bank of 1792 was being redeveloped.

That the Middle Bank had increased in size, and Sandy island moved over a quarter of a mile W.NW., giving 8 fathoms of water where the beacon of 1850 stood, and the bifurcation of the bank, bare at low water, west of it. Compared with the surveys of 1839 and 1841, we find that one part of Sandy island has retained the same position, but that a mile, stretching E. by S. $\frac{1}{2}$ S., has been completely cut away, and is now crossed by the south channel.

That the Clatsop spit has changed its shape, trending more to the westward.

And that the western tail of the great Middle Bank, east of Point Adams, occupies the position of 1839 and 1841.

No survey has been made subsequent to that of 1852, but we can state, from personal observation, that in October, 1857, the south bar was within less than a mile of the beach south of Point Adams, and that the channel ran nearly parallel with, and not distant more than three-quarters of a mile from the shore. It was unavailable with a very heavy sea on, as a vessel had to run it in the trough of the sea, and for sailing with a NW. wind it was a dead beat. We entered the north channel in May, 1857, and found it wide and straight. It was reported to have one fathom more water on the bar than the south. Those of the old buoys that remained were of no use, on account of having been carried from their proper stations.

Conclusions.—From all these examinations, aided by plotting the outlines upon the same sheet and to the same scale, from corroborative evidence, and from personal observation, we find that the south point of the north sands stretching out from Cape Disappointment has remained nearly the same since 1839, bearing S. $\frac{3}{4}$ W. from the light-house, distant $2\frac{1}{2}$ miles; has not varied its position half a mile; has never reached the southern shoal of 1792; and that the bar has never had less than 4 fathoms upon it, thereby indicating that this entrance and channel is the less changeable, and has a fathom more water than the other, and that, with well appointed buoys off its entrance and range beacons on Sandy island and Chinook Point or Scarborough Hill, it will always prove the safer and better for the interests of the country.

The position of the south entrance is continually changing, and the same causes that closed it between 1839 and 1841 will again close it.

The formation of Sandy island precludes the probability of the channel returning to the capacity which existed at the period of Broughton's survey in 1792.

The great Middle Bank, stretching from Point Ellis nearly to Point Adams, remains almost the same since its first determination.

Hydrographic sketches of the entrance to the Columbia river were issued from the Coast Survey Office in 1850 and 1851.

POINTS INSIDE OF COLUMBIA RIVER ENTRANCE.

Sandy Island, (1851.) It is about one-third of a mile long, E.NE. and W.SW., by 250 yards in width, and consists of loose sand raised a few feet above the river, and covered with drift logs, trees, &c. To the westward of it extend two sand bars nearly a mile in length, and bare at low water. The surveys of 1839, '41, '50, and '52 show that this part of the Middle Bank has occupied one position, and will doubtless retain it. In 1792 the main channel of the river passed over this position, and a line of soundings in 5 fathoms ran across it. Considering the immense amount of huge trees coming yearly down the river, we can readily imagine a theory for its formation. A large beacon erected upon it, distinguishable outside the bar, and ranging with another on Scarborough Hill, would serve to denote the position of the north channel.

From Cape Disappointment light-house it bears E. by S. $\frac{1}{2}$ S., distant $3\frac{1}{6}$ miles.

It received its present name from Belcher in 1839. On the Coast Survey charts it is called Sand island.

Chinook Point lies N. by E. $2\frac{3}{4}$ miles from Point Adams, and E. $\frac{1}{4}$ N. $4\frac{3}{4}$ miles from Cape Disappointment. It is a long, low sand strip at the base of the high wooded hills behind it. One of the hills, called Scarborough, is readily recognized by a great part of its southern slope being destitute of trees and covered with fern; no other hill near this vicinity possesses this peculiar feature.

A number of fishing and Indian huts are situated upon the Chinook beach, the people being engaged in catching and curing salmon, with which the waters abound. The mode of catching them is by means of nets; those of Indian construction being made of twine spun from the fibres of the spruce roots, and sometimes from a peculiar grass obtained from northern coast Indians. The mode of curing is very rude and inefficient, and thousands of barrels that have been shipped have proved worthless. There is no reason why this should not become a large and profitable branch of business. The fish are the largest on the coast, often exceeding 80 pounds weight. We have purchased them weighing between 50 and 60, caught upon the beach at the sea base of Cape Disappointment. They commence to run about the end of May, and become remarkably plentiful by the third week in June. The Indians suppose that the salmon, coming directly from the ocean, linger about the entrance several weeks before starting up the river, because they require time to become accustomed to the fresh water; attributing to a wrong cause this normal habit of the salmon.

Chinook Point was the special location of the once powerful tribe of Chinook Indians, and here the celebrated one-eyed chief, Concomly, held sway. The tribe has dwindled to less than a hundred persons—men, women, and children—and they are poor, miserable, drunken, diseased wretches.

The point was called Village Point by Broughton in 1792.

In 1839 it was called Chenoke Point by Belcher. The Indian name is Nóse-to-ilse.

Point Ellis is $2\frac{3}{4}$ miles, nearly, east of Chinook Point; the sand beach between the two being in some places nearly a mile wide, running at the base of the hills and surrounding a large lagoon near Chinook. From Point Adams it bears NE., distant $4\frac{1}{3}$ miles.

Behind Point Ellis rise two hills, the southern of which is used as a range with Point Adams for denoting the entrance to the south channel, but of course the relative positions vary with every change of the bar.

It was called Ellis Point by Belcher in 1839, and Point Ellice by the United States Exploring Expedition in 1841, and this spelling is found upon all recent maps.

The Indian name is No-wehtl-kai-ilse.

Astor Point lies E. $\frac{3}{4}$ N., distant $5\frac{1}{3}$ miles from Point Adams. It is low at the river bank, but has moderately high wooded land behind it. The southern channel passes close to it. The name is derived from a Coast Survey triangulation and secondary astronomical station upon it, but it is in reality a part of Point George.

The geographical position of the station, which is about a quarter of a mile westward of the bay, in front of the town, is—

	°	′	″	
Latitude	46	11	27.6	north.
Longitude	123	49	32	west.
	h.	*m.*	*s.*	
Or, in time	8	15	18.1.	

Point George is the first point made after passing eastward of Clatsop beach. Immediately behind it the land is high and densely wooded; and around its southern face opens Young's river.

It was called "Point George" by Broughton in 1792; "George Point" by Belcher in 1839; "Young's Point" by the United States Exploring Expedition in 1841; "Smith's Point" by the Coast Survey, in the triangulation of 1852; but it is, we believe, generally known as *Young's Point.*

Tongue Point bears E. NE. $8\frac{3}{4}$ miles from Point Adams, and NE. $\frac{1}{3}$ E., $3\frac{1}{2}$ miles from Astor Point. It is a high, bold bluff covered with trees, and connected with the main by a moderately low, narrow, strip of land. As first made, off the entrance, it appears like a low wooded island. Close to it runs the Woody Island channel, which is plainly foreshadowed in Belcher's survey of the river. Between the last two points lie the rival villages of Upper and Lower Astoria. The lower is the most western, and on the location established by the Pacific Fur Company in 1811, and to which was given the name of Astoria. A large saw-mill is in operation here, and a military post was established but abandoned a few years since. The place contains less than fifty houses, and at one time, as a landing place, had an unenviable reputation on account of the character of the "beach combers."

The name of the place was changed to Fort George in 1813, on being taken by the sloop-of-war Raccoon. The original name was restored in 1818.

At Upper Astoria is located the custom-house, off which is the rendezvous of the United States revenue cutter. A large saw-mill is built here; and a government military road is being opened to Salem, on the Willamette river. Between the village and Tongue Point lies the wreck of the Silvie de Grace.

Cape Broughton is on the north side of the river, N. NW. $3\frac{1}{4}$ miles from Tongue Point, and NE. $\frac{1}{4}$ E. $5\frac{3}{4}$ miles from Ellis Point.

It was named by Belcher in 1839, but was called Gray's Point by the United States Exploring Expedition. This last designation was also applied by the Coast Survey in 1852.

The head between Ellis Point and Cape Broughton was named Chatham Head in 1839.

Gray's Bay lies to the NE. of Cape Broughton, and was named, in 1792, in honor of Captain Gray.

Young's Bay lies between the eastern part of the Clatsop beach (called Tansey Point) and Point George. Into it empty Young's river, discovered, examined, and named by Broughton; Lewis and Clarke's river, examined by them in 1805; and one or two small streams or sloughs.

Baker's Bay lies between Cape Disappointment and Chinook Point. It runs 2½ miles to the northward of the cape, and receives the waters of the small streams which head toward Shoalwater bay, and connect with it by a small portage. The western and largest stream is the Wal-la-khut; the eastern, half-way between the cape and Chinook Point, is the Wap-pa-looche.

Two or three houses on the shore of the bay, and a saw-mill, are all that remain of the settlement once designated as "Pacific City." The bay was named in honor of Captain Baker, whom Broughton found anchored here in the schooner Jenny, of Bristol, when he entered.

The Columbia river was called the "Oregon" on the strength of the accounts of Carver in 1766. Much doubt exists as to the origin of the name last mentioned.

In 1775 it was called "Assumption Inlet" by Heceta, but afterwards the Rio de San Roque, from his naming the northern cape San Roque; and also the Enseñada de Heceta.

In 1789 Meares called it "Deception Bay."

In 1792 it was named the "Columbia's river" by Gray.

Clarke says that, in 1805, the Indians knew it as the Shocatilcum, and another name obtained from another body of the natives was Chockalilum; the two being evidently the same word differently pronounced; the accent should be on the penult.

When the name given by Gray was first changed we cannot state. It was, perhaps, done by Vancouver or Broughton.

Lewis and Clarke, in noticing the growth of trees on the Columbia, mention a fir near Astoria that was 230 feet high, and 120 feet of that height without a branch. Its circumference was 27 feet. This same tree is doubtless referred to in the narrative of the United States Exploring Expedition, where the dimensions are given as follows : 39½ feet in circumference at 8 feet above the ground; bark 11 inches thick; height of the tree 250 feet and perfectly straight. Visiters used to be shown "the big tree" as one of the notable sights of the locality.

Belcher says that "the timber of the Columbia, either for spars or plank, cannot be compared to that of higher latitudes; for topmasts and topgallant masts it is probably as tough, but heavier. * * * * Probably no part of Western America can produce timber of the dimensions grown in the regions of the Columbia and the northern confines of California. Amongst the *drift* trees, on the banks of the Columbia, we measured one 174 feet long by 20 feet in circumference, and many 150 feet by 13 to 18. These, of course, were washed from the banks, and therefore not the largest, which grow invariably in the thickest part of the wood."—(Vol. 1, p. 300.)

In Baker's bay, in 1851, we measured a drift tree which had been thrown upon the beach. It was 267 feet long, 27 feet in circumference with the bark peeled off, and where broken at the small end 20 inches in diameter. Very frequently, when trees are felled for cutting into lumber, the first 30 or 40 feet of the trunks are found too large for the saw-mill, and have to be cut off and left on the ground.

GENERAL COURSE OF THE COLUMBIA RIVER.

From the entrance to the mouth of the Cowlitz river the general course of the Columbia is E. by N., and the distance in a straight line 46 miles from the bar, and by the windings of the river about 52 miles. The Cowlitz runs N.NW., and is navigated by canoes about 15 miles to the Cowlitz Landing. At this place travellers take mules or horses to go through to Puget's Sound, a trip of 50 miles. On the west bank of the Cowlitz are a few small houses, locally known as the town of Monticello. On the south bank of the Columbia, opposite the Cowlitz, is another small settlement, called Rainier.

From the Cowlitz the next course of the Columbia is SE. $\frac{3}{8}$ S. for 27 miles to the mouth of the Willamette river,* about 16 miles above the Cowlitz. The Warrior branch or slough of the river makes in from the west side and runs around Multnomah island, coming into the Willamette two miles above its mouth. The Willamette continues the same general course of the Columbia for 16 miles to the falls, where is situated the town of "Oregon City," destined to become a place of importance, on account of the extensive water power; the river there falling perpendicularly 38 or 40 feet. Six miles lower down on the Willamette is the rapidly improving town of Portland, situated at the head of ship navigation, with a population of nearly 5,000. The valley of the Willamette is well settled, contains several thriving towns, and is remarkably productive. The course of the river is southward, gradually approaching the coast within 25 miles, in the latitude of Cape Perpetua. In latitude 44° it runs eastward to the base of the Cascade range, which rises between the snow peaks of Mount Jefferson and Mount McLaughlin.

From the mouth of the Willamette the general course of the Columbia to Fort Walla-Walla is NE. by E. $\frac{1}{2}$ E., 170 miles.

Five miles above the Willamette, on the north side, is the military post of Fort Vancouver, which, with the town of Vancouver, covers part of the grounds formerly occupied by the Hudson Bay Company as a mercantile station, but then designated as Fort Vancouver. The Hudson Bay Company still have a trading station here, but their farms and grazing lands have been occupied by settlers. The site for a town is one of the most beautiful on the river, and capitally located for increasing trade.

About 30 miles further up the river we reach the foot of the Cascades, which are a series of rapids 4 miles long, where the river bursts through the eastern part of the Cascade range of mountains, whose basaltic walls rise precipitously over 3,000 feet on either side, presenting a magnificent sight. Below the rapids the current rushes by with great velocity and depth, but small steamboats ply regularly from Portland and Vancouver to the foot of the rapids; thence passengers are carried by stages to the head, where one or two fine steamboats convey them 50 miles to the Dalles. The Hudson Bay Company carried their large trading boats up the rapids by a system called cordelling. Steamboats have gone up one or two miles, and, in one instance, a brig, with every sail set and a moderate gale astern, was carried safely to the foot of the railroad, which runs from the head to within a mile and a half of the lower end. At each extremity of the rapids are small military posts.

The snow peaks of the volcanic Mt. St. Helens and Mt. Hood lie exactly in line with the Cascades, the former NW. $\frac{1}{4}$ N., 35 miles distant; the latter SE. $\frac{1}{4}$ S., 28 miles distant.

At the Dalles the river is contracted between narrow perpendicular walls, and during freshets rises 100 feet above its ordinary level.

* A corruption of the Indian name. This stream is the Multnomah of Lewis and Clark.

West of the Cascades the forests cease, and above the Dalles stands the only tree in a stretch of 60 miles beyond Walla-Walla, where the river makes a great bend to the northward, in the direction of its source at the base of the Rocky mountains.

On the lower part of the Columbia and Willamette many saw-mills have been erected since the gold discovery in California, and a large trade was carried on in lumber. Between San Francisco and Portland a very large and increasing general trade exists.

The weather off the Columbia entrance is cold and wet with occasional thunder storms, but these are rare. Vancouver says he saw several water spouts off it in October, 1792, some of them were quite near his vessel.

SHOALWATER BAY.

The bold cliffs of Cape Disappointment, after extending about three miles northward, change suddenly to a low, broad, sandy beach, running N. by W. ½ W. 18 miles, in nearly a straight line to the southern point of the entrance to Shoalwater bay. A mile and a quarter behind this beach lies the southern arm of the bay. Its waters reach within a mile or two of the north side of the cape, and the portage from them to the Wappalooche, emptying into Baker's bay, is said to be about a mile long, and always used by the Indians and settlers. The peninsula thus formed is covered with trees and a dense undergrowth of bushes. Within half a mile of its extremity it becomes very low and sandy, and has a covering of coarse grass but no trees. This point was called Low Point by Meares in July, 1788. On the recent Coast Survey charts it is named Leadbetter Point. The Indian designation is Chik-lis-ilh. Its approximate geographical position, as given by the Coast Survey, is:

	°	′	″	
Latitude	46	36	45	north.
Longitude	124	00	45	west.
	h.	*m.*	*s.*	
Or, in time	8	16	0.3.	

Magnetic variation 20° 35′ east, July, 1851, with a yearly increase of 1′.4.

CAPE SHOALWATER.

From Leadbetter Point the north point bears NW. by N. ¾ N., 5½ miles distant. Half a mile of the point is low, sandy and destitute of trees, but some tolerably high land covered with wood rises immediately behind it, being the only elevated ground between Cape Disappointment and Point Grenville that approaches the shore-line. On account of this formation of the point it has been said that the entrance resembles that of Columbia river. We have been unable to detect any resemblance after passing near to it several times. The isolated position of Cape Disappointment and the seaward face of its bold cliffs without trees form a peculiar feature. This, with Scarborough Hill, partly bare, lying 5 or 6 miles east of it, the high mountains inland, and in clear weather the beautiful snow peak of Mount St. Helens, have no counterparts at Cape Shoalwater, and, without mentioning the light-house, should remove all doubt in regard to general resemblance.

The point was named Cape Shoalwater and placed approximately in latitude 46° 47′ by Meares in July, 1788. In 1792 Vancouver assigned the latitude of 46° 40′. It was viewed from the north side of Cape Disappointment by Lewis and Clarke in 1805, and called Point Lewis, but is now frequently known as Toke Point, from the name of an old Indian chief living here in 1854. The Indian name of the point is Quahpt-sum.

THE ENTRANCE.

There having been no survey of Shoalwater bay previous to the preliminary one of the Coast Survey in 1852, and the completion of it in 1855, it is impossible to state what changes have taken place. Judging by the changes of the Humboldt, Umpquah and Columbia bars, we should conclude that similar effects take place here. In less heavy weather than would cause the sea to break on the Columbia river bars, it breaks here with fury quite across the entrance. This description applies to 1852. Charts have been published by the Coast Survey of the respective dates already mentioned.

Four miles off the entrance a depth of 10 fathoms is found, and when well off shore a high double peaked mountain shows to the eastward, well inland; Meares noticed it and placed it in latitude 46° 30′, quite close to the coast, designating it as Saddle Mountain, a name it still retains although one of the same name is found SE. of Point Adams.

At the present time there are two channels, denominated from their position, the *north* and *south channels*, with a large shoal called the *middle sands* lying between them, and partly outside of the line joining the two points.

The bar at the *south channel* has 4 fathoms of water upon it, is a mile wide, and lies two miles off the beach south of Leadbetter Point, with the northernmost trees bearing NE. by E. Running in on this line a vessel shoals her water from 10 fathoms three miles off shore to 4 fathoms two miles off; then gradually deepens it to 5 fathoms, when she should haul close up under the point of breakers northward of her and about half a mile distant; run along in from 6 to 7 fathoms until abreast of the low grassy point, when the course of the channel will be N. by W. ½ W. for 1½ mile, with from 8 to 10 fathoms, hard bottom, its outline being well marked by the breakers outside. From thence a course NE. by N. for two miles will lead to 18 fathoms, and over a mile inside of the line joining Leadbetter Point and Cape Shoalwater, the western trees on Leadbetter point bearing S. ½ E., 3¾ miles distant. If the tide is low, sand bars and flats will show on both hands, one directly ahead; the broad deep channel to the SE. distinctly marked by bare patches on either side; and a narrow, deep channel to the northwest running into the north channel. From the last position the western trees on Leadbetter Point bear south, distant 4 miles. The greater body of water passes through this channel, and the current runs very strong. In summer, with a northwester blowing, it is a dead beat after passing the bar, and in some places the channel is less than half a mile wide between the 3-fathom curves. Coasters do not enter it except with a southerly wind, and always pick out the channel from aloft. In summer they have a leading wind out, and start on the first of the ebb.

The bar at the *north channel* has about 3¼ fathoms upon it, and bears SW. by S. ¼ S. three miles from the southern extremity of Cape Shoalwater. It is about a mile in extent within the 3-fathom curve.

In making the bay from the southward in summer work to the northward of Cape Shoalwater, then run in and follow the shore outside of the breakers in 6 or 7 fathoms, gradually approaching them and decreasing the depth to 4½ and 4 fathoms, when the southern side of the elevated ground of the cape bears NE. by N. ½ N. Then head up as near that course as possible, crossing the bar in 3¼ fathoms, and continuing in that depth for at least a mile and a quarter, taking care not to decrease it on either hand. Keep under the breakers on the north side in from 5 to 7 fathoms, hard bottom, and increase the depth to twelve well inside of the point, when its southern extremity should bear NW. ½ W., distant 1½ mile. If it is low water, sand banks will show in different directions, and the channels will be tolerably well marked.

The present invariable practice of vessels entering is to seek out the channel from the mast head. In calm weather the channels must be known or a pilot employed, if one is to be found.

The north bar bears NW. by N. ⅜ N., distant 5 miles.

The *middle sands* lie between the two channels. The southern tail is SW. 1⅞ mile from Leadbetter Point; runs NW. by N. ⅜ N. for 2¼ miles; then N.NE. 2¼ miles; and E.NE. 1½ mile, with an average width of 1¼ mile. One mile outside of it soundings are found in 7 fathoms.

This bay, as its name implies, is so full of shoals that at low tides about one-half of its area is laid bare. Good but narrow channels are found thoughout its extent, but no direction can be given for running them. Without a knowledge of them, or without a pilot, follow them only at low water. The currents then run with great velocity, and it is very difficult and frequently impossible to keep a course against them. The arm stretching southward toward Baker's bay is 15 miles long from Leadbetter Point, with an average width of not less than 3½; whilst the upper portion stretches to the NE. for 9 miles to the north of the Whilapah river, reckoning from the middle of the line joining Cape Shoalwater and Leadbetter Point.

The principal stream emptying into the bay is the *Whil-a-pah*, at its northeast part. At about 9 miles from Cape Shoalwater it is less than a quarter of a mile wide, with low swampy banks and steep bluffs on each side about a mile and a half apart.

The mouth of the *Palux*, or Copalux, lies 5 miles NE. ½ E. from Leadbetter Point. It is half a mile wide at its mouth; contracts very much in two miles, and is bordered by marshes with numerous sloughs running through them.

The *Násal* enters about 11 miles south from the Palux, and abreast of the middle of Long island. It has over 20 feet water at its mouth, with bluff banks for some distance until it begins to expand, when it is bordered by flats.

Several streams open from the north side of the bay. One of these, the Necomanche, near the Whilapah, has 6 feet in the main channel, and shows 1½ mile wide at high tide.

There are three islands in the bay. *Pine island*, about 1½ mile NW. by N. off the mouth of the Palux, is a small sand islet of only four or five acres in extent, and occupied by oystermen. It is near the channel and oyster beds, which stretch for a couple of miles to the N.NE. of it. The north end of *Long island* is 8 miles from Leadbetter Point. This island runs irregularly about SE. for 6 miles, and has an average width of 1½ mile. It is covered with a dense forest of fir and undergrowth. One mile S.SE. of Long island is a very small islet called *Round island*, of only a few acres in extent, covered with wood and bushes. The shores of the bay, except on the peninsula, are mostly composed of perpendicular cliffs of a sandy clay, in which are strata of recent fossil shells and the remains of trees. Where the faces of the cliffs are not washed by the waters of the bay they slope gently and have a small grassy shore at their base.

NE. ¾ N., distant 6 miles from Leadbetter Point, is a sharp narrow cliff, 60 feet high, making out into the bay, which is wearing it away, and has exposed many large basaltic boulders. No other place on the bay presents this geological feature.

The *peninsula* is a long, flat, marshy, and sandy plain, elevated but a few feet above the level of the sea, and covered, like the entire surface of this country, with a dense growth of gigantic forest trees, principally spruce, fir, and cedar, with a few specimens of maple, ash, and black alder. The spruce frequently attains a diameter of 8 feet.

The shoals are covered with shell fish, among which the oyster is the most abundant, and the principal article of export. They are small and have a coppery taste. Codfish and halibut abound; sturgeon, said to be of good quality, are plenty; and salmon of several varieties and excellent flavor exist in infinite numbers. In spring vast shoals of a small herring enter the bay. In winter wild fowl are innumerable, but these have been made shy by the bad shooting of the Indians. Black and white swan, geese, mallards, canvass backs, &c., always reward the experienced sportsman.

The yearly shipment of oysters is about 30,000 bushels, and of piles and spars about 30,000 feet. The average valuation of exports is $120,000. The number of vessels entering yearly is about 25, nearly all of which are schooners, counting an aggregate of 2,500 tons. In 1855 the population on the bay was 190 males and 60 females.

This bay was discovered by Lieut. John Meares, July 5, 1788, in the Felice, when proceeding in search of the Rio de San Roque of Heceta. He approached it until the water shoaled to 8 fathoms, when the breakers ahead warned him to haul off. "From the mast-head it was observed that this bay extended a considerable way inland, spreading into several arms or branches to the northward and eastward, and the mountainous land behind it was at a great distance from us." He saw "what appeared a narrow entrance at the northwest part of the bay," but it was too remote for him to discover whether it really was so or only low land. "From under the [low] point a canoe came out, containing a man and boy," &c. Unsettled weather prevented his sending in the long boat to sound near the shoals, in order to discover whether there was any channel. He called it Shoalwater bay.

Vancouver endeavored to enter in 1792, but, as it was breaking across the whole entrance, he considered it inaccessible to his vessels. He says "the sandy beach was bordered by breakers extending three or four miles into the sea, and seemed to be completely inaccessible until 4 p. m., when the appearance of a tolerably good bay presented itself," and the point to the north "somewhat more elevated than the rest of the coast," and in latitude 46° 40′.

It is asserted by settlers here that boats, canoes, &c., which have broken adrift and gone out of the bay, have, in every instance, been found on the beach north of the entrance, and generally between it and Gray's harbor.

The light-house at Cape Shoalwater, at the north point of the entrance to Shoalwater bay, is a structure consisting of a keeper's dwelling, with a tower rising through it and surmounted by an iron lantern, painted red. Its height is 41½ feet above the ground and about 87 feet above the mean level of the sea. The dwelling and tower are plastered and whitewashed, and situated about a mile from the extremity of the cape. The illuminating apparatus is of the fourth order of Fresnel, shows a *fixed white light varied by flashes*, and should be seen from a height of—

10 feet at a distance of 14¼ miles.
20 feet at a distance of 16 miles.
30 feet at a distance of 17 miles.

It was first exhibited on the 1st of October, 1858, and shows from sunset to sunrise. The approximate geographical position of the light, as determined by the Coast Survey, is:

	° ′ ″
Latitude	46 44 11 north.
Longitude	124 02 24 west.
	h. m. s.
Or, in time	8 16 09.6.

GRAY'S HARBOR.

From Cape Shoalwater a fine, hard, low sand beach runs N.NW., nearly straight, 13 miles to *Point Hanson*, the southern point of the entrance to Gray's harbor. The country behind this beach is low, flat, and densely covered with trees. Near the extremity of the point is a slight rise in the ground.

In giving a description of the bay we can state nothing from personal experience. The only preliminary surveys made are those of Vancouver's expedition in 1792, and of the United States Exploring Expedition in 1841. No survey has yet been made by the Coast Survey, except the approximate determination of the entrance in the reconnaissance of 1852.

From the southern point of the entrance *Point Brown*, on the north side, bears NW. ¾ W., nearly 2¼ miles distant. Inside of these points the bay spreads out suddenly, and contracts at the mouth of the Chehalis river. This gives it a heart-shaped or triangular form, with the base of the triangle towards the Pacific, and the apex at the Chehalis. The shores are low, except in two places, and the whole northern portion of the bay is an extensive flat, bare at low water.

Point Brown is the commencement of a large sand waste, stretching towards the Copalis river. It is covered with coarse beach grass and stunted lupin bushes, and is cut up with the tracks of bears, cougars, elk, wolves, &c. The peninsula of Point Brown extends NW. by N. for 8 miles, with an average width of 2½ miles.

At the time of Whidbey's survey, under the orders of Vancouver, a bar existed off the entrance, having the following position: From Point Hanson, SW. by W. ½ W., 3½ miles distant, and from Point Brown, SW. by S. ¼ S., 4 miles distant. He does not give the depth of water on the bar in his chart, but in the narrative states it to be 3 fathoms. From this bar the channel was a mile wide, and straight to the entrance between the points; was well marked by the breakers; had from 4 to 10 fathoms in it until nearly abreast of the points, where it was contracted to half a mile and the depth increased to 14 fathoms. Then it opened suddenly to both points with from 3 to 6 fathoms between them. The course in, over the bar and through mid-channel, was NE. ¼ N., for 3¼ miles to between the points, with two low sand islands in range on the course, and 6½ miles from the bar. A narrow channel existed on either side of these islands towards the Chehalis; the southern channel having from 3 to 4 fathoms, and that on the north side 5 or 6.

In the indentation SE. of Point Hanson lay an island with a channel on either side, but that on the west was the better. Both led to the mouth of a small stream coming in from the east. He also gives a 4-fathom channel on the east side of Point Brown peninsula, and surveyed two miles up.

From Point Brown he states *Point New* to be N. 65° E., (true,) 4¼ miles distant, and marks the point on the chart with two rocks off it; but it is not on the proper bearing mentioned in the narrative, unless he took his bearing from the astronomical station. That part of the bay shore near Point New is composed of cliffs for 2 or 3 miles.

The mouth of the Chehalis, which he does not show, is placed NE. by E. ½ E., 8¼ miles from Point Brown, the line passing over the centre of the island which lies in the middle of the bay, and is 2½ miles from the point.

That the bar and general features of the sands have changed much since that time we propose to show from an examination of a reduced copy of the survey by the United States Exploring Expedition in 1841. Here we find no island in the middle of the bay, nor any east of Point Hanson, but a large one $1\frac{3}{4}$ mile long by half a mile wide in the middle of the entrance, and connected by a shoal with Point Brown, whilst the channel then ran between this island and the southern point. The bar bore SW. $2\frac{1}{4}$ miles from Point Brown, and west $2\frac{1}{2}$ miles from Point Hanson, with a depth of about 3 fathoms. This position shows that the bar had moved to the N. by E. no less than two miles.

From Point Brown a small bluff on the east side of the bay bears E. $\frac{1}{2}$ N., $6\frac{1}{2}$ miles distant, with a high hill behind it in range. From Point Hanson this bluff bears E.NE., $5\frac{3}{4}$ miles distant. From Point Brown the mouth of the Chehalis bears NE. by E. $\frac{3}{4}$ E., distant 12 miles, differing considerably from Whidbey's determination; and Point New, from the same point, bears NE. $\frac{1}{3}$ N., distant $5\frac{1}{2}$ miles.

The next survey will prove what recent changes have taken place, and whether the directions of one season can be relied upon for the next. We have been off the bar but never saw a fair chance for entering. According to the charts of the United States Exploring Expedition the course for crossing it was to bring Point Hanson to bear east and run for it, the channel being straight.

In the winter of 1852–'53 the brig Willimantic was driven ashore upon the island at the entrance, having mistaken this for Shoalwater bay. After vainly attempting to launch her toward the sea she was dragged across the island and launched on the bay side. Then the island was a mere bank of sand, bare at all tides, and covered with logs and drift wood.

It is stated that close under Point Brown a swash channel exists, which the Indians always use to save crossing the bar.

The bay was discovered by Gray in May, 1792, and named Bulfinch harbor, after one of the owners of his vessel. He placed it in latitude 46° 58′ north.

It was surveyed by Lieutenant Whidbey, in the storeship Dædalus, October, 1792, under the directions of Vancouver. He first sent in his boats, and then crossed the bar in three fathoms, with the ebb current running so strong that, although the ship was making nearly five knots an hour, little actual progress was made. He applied the present name, Gray's harbor, in compliment to its discoverer. On some old maps we have found it called Whidbey's harbor. He named Point Hanson after the commander of the Dædalus, and the northern point he called Point Brown, placing it in latitude 46° $59\frac{1}{3}$′ north.

The southern point was called Point Chickeeles, and the same name was applied to the river.

In the recent maps of the Coast Survey, Point Brown is plotted in latitude 46° 57′, longitude 124° 04′, and the southern is termed Point Harrison. Among the few settlers in this region it is called Point Armstrong.

The name of the river is derived from the Indian tribe inhabiting the bay and river. They pronounce it Tché-há-lis.

The country behind the bay is low and flat, receiving the waters of the Chehalis from the eastward. This river is said to be navigable for boats for a distance of 60 miles, and to drain a timbered, well watered country, abounding in many small prairies.

For January, 1859, the *line of equal magnetic variation* of 21° east crosses the coast line in latitude 47° 08′, and in latitude 46° 58′ it crosses the 125° of longitude. This line moves annually a mile and a half to the southward.

COPALIS RIVER.

We know nothing of this stream except from settlers who have passed it in travelling along the shore.

From Point Brown the shore-line trends about NW. by W. for 5 miles; then N. by W. ½ W. for the same distance to the mouth of the Copalis. The barren waste of Point Brown continues along this shore, commencing with a width of nearly two miles, stretching from the ocean to a dense forest of fir, and growing narrower as it approaches the Copalis, where the timber comes to the water's edge.

This stream is about 100 yards wide, but the mouth is almost closed by a bar. Upon its banks reside the Copalis tribe of Indians, from whom the river derives its name. Like all the streams on this coast it abounds in salmon, but those caught here are celebrated for their succulent richness of flavor. Their general appearance is similar to those of the Columbia river, but this variety rarely exceeds two feet in length. They weigh from five to ten pounds.

In or about October, 1854, there was discovered, one mile north of the Copalis, the whole stern frame of the propeller General Warren, which had been wrecked on Clatsop spit, at the mouth of the Columbia river, more than two years previously, having thus been carried by currents at least 60 miles from its original position. When the hydrographic survey of the entrance to the Columbia was made by the Coast Survey parties in 1852 this wreck was found and its position determined. From Cape Disappointment it bore SE. by E., almost 4 miles distant, and was consequently little more than a mile from Point Adams. It then rested on the north edge of the Clatsop spit. This shows a direction of the current corroborating Vancouver's account when anchored off Destruction island.

POINT GRENVILLE.

From the Copalis to this point the shore runs NW. ½ N. about 16 miles, and continues low, nearly straight, and bordered by sand beach, which changes to shingle, disposed in long rows parallel to the coast. These ridges of shingle dam the mouths of many small streams and form ponds, abounding in trout, and well stocked with beaver and otter, according to the accounts of the Indians. The high land also approaches much nearer the beach and forms sandstone cliffs, with rocky ledges projecting into the ocean.

Point Grenville is a bluff, rocky promontory, stretching westward about a mile, and then southward about a quarter, forming a very contracted and exposed roadstead; with the 3-fathom curve extending half a mile from the beach, compelling vessels, except of very light draught, to anchor so far out that the point and the rocks off it afford but little protection from the northwest winds. It is useless during the winter months. The point has high hills lying behind it, and many rocks immediately off it; two of these, about 75 feet high, lie E. by S. 400 yards distant; another lies SW. ¾ S. half a mile distant. This, we believe, is the one which shows a large perforation through it when viewed from the southeast or northwest. It has 5 and 6 fathoms all around it. Others stretch along the coast to the northwest, one of them showing from the south as a leg-of-mutton sail. The bluff itself is composed of fine sandstone, is very steep, and may be ascended by a difficult trail, which is used by the Indians. It is said to be a great resort for sea otters, which are hunted by the natives.

Its approximate geographical position is:

	°	′	
Latitude	47	20	north.
Longitude	124	14	west.
	h.	*m.*	*s.*
Or, in time	8	16	56

From Cape Disappointment light it bears NW. by N. ½ N. distant 62 miles, and from the cape soundings may be had in from 8 to 15 fathoms, 3 or 4 miles from the shore.

This point is said to be the Punta de Martires of Heceta and Bodega, because in latitude 47° 20′ seven of the crew of Bodega's vessel, the Señora, were massacred by the natives.

It received its present name in 1792, from Vancouver, who placed it in latitude 47° 22′, and describes as lying off it "three rocky islets, one of which, like that at Cape Lookout, is perforated."

North of Grenville to Cape Flattery the shore is bold and rocky, with occasional short reaches of sand beach. The timber comes down to the water; moderately high hills approach the coast, through which empty numerous small streams, whilst the irregular Olympus range rises far in the interior. In winter these mountains are covered with snow, which lies in the gorges and valleys nearly the whole summer. *Mount Olympus* is the highest peak of the range. It attains an elevation of 8,138 feet, according to determinations made in 1841, which also place it in latitude 47° 45′ N. and longitude 122° 37′ W.

It is said to have been first seen by Perez, in 1774, who placed it in 47° 47′ N., and called it La Sierra Santa Rosalia, but the account of his voyage was not published until many years after that date.

It was next described by Meares, in 1788, and placed in latitude 47° 10′, the error arising from its bearing, and he supposing it much nearer the coast-line than it actually is. In his sketch it is marked quite close to the shore, in latitude 47° 15′ N. He called it Mount Olympus, the only name by which it is now known.

In 1792 Vancouver determined its position approximately, and gave the latitude as 47° 50′ N.

Qué-ni-ült River.—The mouth of this small stream is between three and four miles NW. by W. from Point Grenville, and is almost closed by the shingle and gravel thrown up by the surf, which leave, however, a contracted opening for the passage of canoes in calm weather. The closing of the entrance has so dammed the river as to form a small lake inside, upon the banks of which is situated a village of the Queniults, a race of Indians hostile to all other tribes. Combined with others to the northward they have ever been notorious for their hostility and vindictiveness to the whites. Several Spanish, English, and Russian vessels and their crews were, in former times, taken and destroyed. Hence we meet with the names Destruction Island, Isla de Dolores, Punta de Martires, &c., in this immediate vicinity. The river is said to head in a lake at the foot of the mountains.

The name of this river is usually known by the old settlers as Qué-noith, but the Indians are said to pronounce it as if spelled Qué-ni-ült, accenting the first syllable strongly, and the last so softly that many persons consider they call themselves simply Qué-nai. A tribe still further north is called the Que-nait′-sath.

These Indians, when travelling by canoes along the low sandy beach south of Point Grenville, push out into the rollers, keep between the line of two seas that have broken, and pole the canoe through the surf. This peculiar mode is rather apt to excite the fears of those ignorant of what a canoe can be made to do when skilfully handled.

For four miles above the Queniult the coast trends in the same direction, NW. by W., is composed of sandstone cliffs, and bounded by many precipitous rocks, the height and direction of which are generally that of the cliff. In the Coast Survey reconnaissance of 1852, one is placed 2½ miles off shore in latitude 47° 27′, and the vessel's track is laid down inside of it. A great many large rocky islets lie close in shore in this vicinity, but northward the coast is nearly clear to Destruction island. It makes a slight curve eastward, and alternates with bold yellow cliffs and low shores.

DESTRUCTION ISLAND.

This island is the only one found deserving the appellation after leaving the Farallones. It is about 150 feet high, quite flat on the top, covered with grass but destitute of trees, and has high perpendicular sides of the same height as the cliffs on the main. It is said that there are some remarkable perforations through a rock near it, but these are, doubtless, only seen in particular directions, for, in passing close to it, we have never noticed them. On the eastern end were formerly some rude Indian huts. In Vancouver's time he found two or three dwarf trees at either end.

In running along the coast, 10 miles off, it is very difficult to make out this island, because being within 1½ mile of the main it is projected against the coast cliffs and cannot be distinguished from them until close upon it. It is narrow, but about 1½ mile long in a N.NW. direction running parallel with the coast; has rocks for a mile off its southern end. A reef and sand bank is represented as stretching thence W. NW. 3 miles to broken water, and from there running nearly straight to the northern end. A detailed examination of this locality might prove that good refuge could be had under the island during heavy southeast and southwest weather.

Between it and the main the soundings range from 7 to 12 fathoms, and to the northward from 10 to 14.

The approximate geographical position of the north end is:

	°	′
Latitude	47	41 north.
Longitude	124	25 west.

From Cape Disappointment it bears NW. by N. 84 miles.

This island is called Isla de Dolores upon old Spanish maps. It received its present name, by which it is only known on the coast, in 1787, from Captain Berkely, who sent a long-boat from King George's Sound to explore as far south as latitude 47°. The crew of a smaller boat entered a shallow river and rowed up some distance, where they were attacked and murdered by the Indians.

In April, 1792, while Vancouver was at anchor in 21 fathoms, 3½ miles S.SW. of this island, he "had calms, and found a constant current, without intermission, setting in the line of the coast to the northward." After passing Cape Orford he had been regularly thus affected, and carried to the north 10 to 12 miles per day further than was expected. He gives the latitude of the island as 47° 37′ north.

W. by N., distant 16 miles from Point Grenville, we discovered, in June, 1855, a bank having 15 fathoms upon it, with very soft mud bottom; at 21 miles distance, 17 fathoms; and at 29 miles, 36 fathoms; and 3 miles S.SE. of the first position we struck 16½ fathoms, with the same bottom, in all the soundings; but had not time to make an extended examination. In April, 1856, we found 45 fathoms in latitude 46° 54′ N., longitude 125° 03′ W., being 16 miles broad off shore. The soundings of 17, 18, and 19 fathoms, one mile from shore, would indicate a greater depth than we obtained. Vancouver has 50 fathoms inside of our first soundings.

From Destruction island northward the shore is composed of cliffs which form a regular curve to a point bearing NW. ½ W. from the north end of the island, and 11 miles distant; thence the shore runs nearly straight on that course for 10 miles to two high bluffs and well marked rocks, standing a mile from shore. The outer one is bold and covered with tall trees, but the inner one is bare. They are in latitude 47° 58′, longitude 124° 40′. Many others, but smaller, lie inside of them, and 19 fathoms are found close outside. Along this stretch the shore is irregular and bluff with many high rocky islets off it. A stream opens about midway in the stretch.

In the indentation northward of Destruction island, and about 4 miles from it, empties a small stream, which we believe is called Hooch by the Indians.

FLATTERY ROCKS.

From the two rocks just mentioned to Cape Flattery, in 48° 23′, the course is almost N.NW., passing through a group of high, well marked, rocky islets, in latitude 48° 12′ N., called the Flattery Rocks. Before reaching these the coast line curves about a mile eastward, with a bluff shore nearly free from rocks for about 8 miles, when a large white rock half a mile out looms up prominently, and is distinctly seen against the main land.

Flattery Rocks extend between two and three miles from shore; the outer ledge is awash with one islet in it, and the track of the coast surveying steamer is laid down inside of it, with soundings in 9 to 20 fathoms. High abrupt timbered islets lie inside, with their ocean faces nearly perpendicular, about 150 feet high, and sloping landward. Where destitute of trees, these are covered with grass, bushes, &c. The latitude of the rocks is 48° 12′ north.

In March 1778, Cook, having been driven seaward by heavy gales off Cape Perpetua, made the land about the latitude of 47° 35′, and 4 leagues from shore, as he says, when he was in hopes of finding a harbor to the northward under a small round hill which appeared to be an island, but on approaching it he became almost convinced that the opening was closed by low lands, and being thus disappointed, he named the point of land to the north of it Cape Flattery, and placed it in latitude 48° 15′ N. On recent English charts the cape is placed in the position of the Flattery Rocks, although Vancouver adopted the present usage on this coast. From an examination of Cook's account, with a knowledge of the coast and the currents here, we are satisfied that he was further north than he estimated on the morning of March 22, for he says the small round hill like an island bore N. ¾ E., (true,) distant 6 or 7 leagues, while the coast extended from N. to SE., (true.) These facts convince us that his position was in latitude 47° 50′, longitude 124° 46′; from this situation the Flattery Rocks are distant 7 leagues, bearing N. ¾ E., (true;) the extremity of Cape Flattery bearing nearly N., (true;) the distance to the nearest point of land a little more than 3 leagues; and the coast northward of Point Grenville bearing SE., (true.) The point of land northward of the Flattery Rocks was, therefore, his Cape Flattery, and his estimated latitude of it 8 miles too small. Before next day he had a very hard gale from the SW., accompanied with rain, and he did not see land again until he reached latitude 49½°. He arrived at the conclusion that between 47° and 48° there existed no inlet, as had been asserted.

From Flattery Rocks we find a high rocky coast, bordered by outlying rocks for 8 miles, when a low sand beach occurs, receiving a small stream which runs E.NE. and finally north, behind the mountain constituting Cape Flattery, to within 200 yards of the beach in Neé-ah bay. A rise of 20 or 30 feet of the sea would make Cape Flattery an island, extending 5 miles (W.NW.)

by 3 miles in breadth. This creek is used by the outer coast Indians during the prevalence of heavy winter gales, when the passage outside the cape would be impracticable.

From Point Grenville to Cape Flattery the hills rising from the coast are about 2,000 feet high, densely covered with trees, and cut up by innumerable valleys. The shore is inhabited by numerous tribes of Indians, accustomed to war and bitterly hostile to the whites. They are far superior to the Indians found along the southern coast. Their villages are heavily stockaded, and the houses made of cedar boards, which they have cut with great industry from the tree. We have measured and found some of these boards to be over 4 feet wide and 20 feet long; the outside edges being about an inch thick and three inches in the middle. Their houses are very large and partitioned off into stalls for each family. The numerous streams emptying upon the coast afford them a never failing supply of the finest salmon; and to obtain means of barter with white traders they fearlessly attack and capture the different species of whale on the coast.

TATOOSH ISLAND.

This island lies W.NW. half a mile from the point of Cape Flattery. It is composed of small islets connected by reefs, is quite flat-topped, and without trees. The surface is 100 feet above high water, and the sides are perpendicular; the entire mass being composed of coarse sandstone conglomerate with an outcrop of basalt on one of the reefs. There is a depth of two or three feet of soil upon the top, which was formerly cultivated by the Indians, who resorted here in summer about 150 strong, and had several houses near the only boat landing on the inside of the island, (1852.) A reef extends a quarter of a mile off the west side of the island, and the whole extent of the island and reef is only half a mile W.NW. by a third of a mile. Deep water is found upon all sides, except between it and the cape, where a reef exists upon which it breaks very heavily in bad weather. We are informed that small vessels have gone through when jammed by an unfavorable wind. In so doing great risk must have been incurred, as the currents in the vicinity run very irregularly and strong.

From the top of the island a leaning rocky column, about 75 feet high and one-third of that in diameter, is seen to the southeastward close under the face of the cape. It is sometimes called Fuca's pillar.

TATOOSH ISLAND LIGHT-HOUSE.

This structure is erected on the highest part of the island, and consists of a keeper's dwelling of stone, with a tower of brick, whitewashed, rising above it and surmounted by an iron lantern painted red, its height being 66 feet above the top of the island. The light was first exhibited December 28, 1857, and shows every night, from sunset to sunrise, a *fixed white light* of the first order of Fresnel, which is elevated 162 feet above the mean sea level, and in clear weather should be seen from a height of—

10 feet at a distance of 18.2 miles;
20 feet at a distance of 19.7 miles;
30 feet at a distance of 20.9 miles;
60 feet at a distance of 23.5 miles;

so that a vessel from the southward will make it before being up with the Flattery Rocks.

The geographical position of the light, as determined by the Coast Survey, is:

	°	′	″	
Latitude	48	23	15.5	north.
Longitude	124	43	50.0	west.
	h.	m.	s.	
Or, in time	8	18	55.3.	

Magnetic variation, 21° 46′ east, in August, 1855, with a yearly increase of 1′.4.

The angle of visibility from the land southward, round by the west to the extreme western visible point of Vancouver island, is 131°, and from the same starting point round by the west, up the strait of Juan de Fuca, 263°.

This island, with its outlying reef, is the most western portion of the United States.

The present name is that given to us by the Indian tribe (Muk-kaw) inhabiting the cape and outer part of the strait. Their word to designate an island is opichuk't.

On June 29, 1788, Meares, passing the entrance to the strait, hove to off this island, was visited by the Indians, and sent an officer to examine it, who reported that it was a "solid rock covered with little verdure, and surrounded by breakers in every direction." They also "saw a very remarkable rock that wore the appearance of an obelisk, and stood at some distance from the island." To this rock he gave the name of Pinnacle Rock. It is the columnar leaning rock already described. He says "the island itself appeared to be a barren rock, almost inaccessible, and of no great extent; but the surface of it, as far as we could see, was covered with inhabitants, who were gazing at the ship." "The chief of this spot, whose name is Tatooche, did us the favor of a visit, and so surly and forbidding a character we had not yet seen." The Indians evidently gave him the name of the island, which he mistook for that of the chief. And here we may be permitted to remark that from this place to Cape Lookout the descriptions of Meares confirm our own observations.

ROCK DUNCAN.

This is a small low black rock rising above the highest tides, but always washed by the western swell, which breaks over it. Deep water is found close around it. From Tatoosh island light it bears N. 33° W., distant 2,078 yards, or more than a mile, and many vessels pass between them, as the chart shows 25 fathoms; but a rock has been reported in the channel, and it would be well to avoid it until the doubt is set at rest. Vancouver's vessels passed between them. The rock was first noticed by Mr. Duncan, and placed in latitude 48° 37′ N., which Vancouver, who gave it the present name, considered a typographical error.

DUNTZE ROCK.

Nearly a quarter of a mile off Rock Duncan, on the line from Tatoosh island, Kellet places a rock having three fathoms water upon it, and to which he gave this name.

With no wind, a heavy swell to the west, ebb current and proximity to these outlying rocks and island, a vessel's position is unsafe, and great caution should be exercised in navigating this part of the entrance to the Strait of Fuca.

CAPE FLATTERY.

This cape forms the southern head of the entrance of the Strait of Juan de Fuca; it has a bold, wild, jagged sea-face, about 100 feet high, much disintegrated by the wearing action of the ocean; rises in a mile to an irregular hill of 1,500 or 2,000 feet in height; is cut up by gorges and covered with a dense growth of fir and almost impenetrable underbrush from the edge of the cliffs to the summit. The shore-line round to Neé-ah bay is of the same forbidding character, bordered by reefs, and having but one short stretch of beach at the foot of the hills, upon which is situated (or was, in 1852,) Clisseet's village. The soundings half a mile from shore are deep and irregular, reaching 68 fathoms. The current runs as much as three miles per hour, and during the ebb sets irregularly round the cape, Tatoosh island, and Rock Duncan. When seen from the southwestward, Cape Flattery looks like an island, on account of the valley three or four miles eastward. The best position for seeing this is when a single rock off the cape shows itself detached. From this direction the high mountains on Vancouver's island loom up and stretch far away to the northwest and to the east.

The extent of ocean shore-line from Cape Disappointment to Cape Flattery is 148 miles.

The name adopted is that which Cook gave to this headland in 1778. It has been called Cape Martinez by the Spaniards, from its asserted discovery, in 1774, by Martinez, pilot to Perez, who announced many years afterward that he remembered to have observed a wide opening in the land between 48° and 49° north latitude.

On recent English charts it is called Cape Classet, because, in 1792, Vancouver stated that as the name given by the Indians to distinguish it, but in a marginal note it is called "Cape Flattery." In 1852 we found that the then head chief of the Muk-kaws, a powerful man, about 40 or 45 years of age, called himself, and was called by the tribe, Clisseet′ but we could not ascertain whether this was or was not a hereditary title.

On the western coast it is universally known as Cape Flat[illegible]y.

It was near this cape that a Japanese junk was wrecked in 1833, accounts of which will be found in Belcher's narrative, and in that of the United States Exploring Expedition.

BANK OFF CAPE FLATTERY.

At the entrance to the Strait of Juan de Fuca, 15 miles, by estimation, W.NW. from Cape Flattery, we have been informed that a bank exists having 18 fathoms upon it, and, moreover, that during a calm our informant fished upon it and caught a large number of codfish. His attention was called to it by a number of canoes fishing. While encamped in Neé-ah bay, in 1852, the Indians frequently went out upon some bank off the strait to fish for cod, but we looked upon their assertions with distrust, and believed they caught the fish inside of the strait. Each season in passing, as we wished incidentally to seek for this bank, we encountered south-east gales, which rendered the examination impracticable.

STRAIT OF JUAN DE FUCA.

The entrance to this strait from the Pacific lies between Cape Flattery and Cape Bonilla, on Vancouver island, which forms the northern shores. Its width is about 14 miles, and the bearing from Flattery to Bonilla NW. ¾ N. From this line the strait runs east for 40 miles, with a uniform width of 11 miles. It gradually contracts to 8 miles between Beachy Head, on the north, and Striped Peak, on the south; changes its direction to E. by N. ½ N. for 15 miles; then expands to the northward. attaining a width of 18 to 20 miles, and divides into two ship channels, the Canal de Haro and Rosario Strait, leading through the Archipelago de Haro, northward, to the Gulf of Georgia. It is terminated on the east by Whidbey island; at the southeast it passes into Admiralty Inlet; and it is bounded on the south by the main land of Washington Territory, which forms the entire southern shore of the strait. From the ocean to Whidbey island the mid-channel distance is 84 miles. The depth of water throughout the strait is remarkably great, no bottom being found in its deepest parts with 150 fathoms of line. It is the main artery for the waters of Admiralty Inlet, Puget's Sound, Possession Sound, Hood's Canal, Canal de Haro, Rosario Strait, Bellingham Bay, and the vast Gulf of Georgia, extending between Vancouver island and New Caledonia for 120 miles, with an average width of 20. Its currents run with an average velocity of not less than three miles per hour, and off the Race islands and Beechy Head over 6 miles an hour. Its shores are bold, abrupt, and covered with a heavy growth of varied timber and dense underbrush. On the north the mountains rise rapidly from the water, and many attain an elevation of not less than 6,000 or 7,000 feet. These are covered with fir to their summits. On the south, for 30 miles from the entrance, the shore is bounded by hills of 2,000 feet height, backed by the jagged Olympus range of 8,200 feet. For the next 50 miles the shore is generally a steep cliff, from 50 to 200 feet high, with a flat country extending nearly to the foot hills of Olympus, and stretching further south as we move eastward. On the east the face of Whidbey island is very steep; it is about 250 feet high and appears flat, as does the whole country eastward to the sharp-cut outline of the Cascade range, stretching its serrated ridge northward where the snow-peak of Mount Baker* is distinctly seen; and to the southward where the higher peak of Mount Rainier* attracts the eye.

At the time of our first visit the southern shore of the strait was inhabited by large numbers of Indians, living in heavily stockaded villages. They were tolerably expert in the use of fire-arms, of which they seemed to have a good supply. They lived mostly by fishing, but raised a fair supply of remarkably good potatoes from the stock seed of the Hudson Bay Company.

During dry summers the Indians and settlers set fire to the forests in every direction, and the country soon becomes enveloped in a dense smoke that lasts for two or three months. At such times it is frequently impossible to make out the shore at half a mile distance; the strong westerly winds coming up the strait disperse it for a while, but only to fan the fires and give them renewed force and activity.

In summer the prevailing wind draws into the strait, increasing towards evening, and frequently blowing a ten-knot breeze before midnight; but unless the wind is strong outside little will be felt in the strait, and very frequently vessels will be a week from Cape Flattery to Admiralty Inlet, or *vice versa*. In winter the southeast winds draw directly out, and create a very heavy cross sea off the entrance, the great southwest swell meeting that rolling out. In such cases trading vessels try to gain Neé-ah bay or San Juan harbor, and remain at anchor until the wind changes. In beating in or out vessels may run as close under either shore as wind and currents warrant, as no hidden dangers have been found half a mile off shore, except at the west side of the small indentation called Crescent bay, near Striped Peak, 44 miles inside of Rock Duncan.

At the entrance the currents acquire, during the "large tide" of each day, a velocity of 4 miles per hour, and, after strong northwest winds, a very large, short, but regular swell is encountered west of Neé-ah bay during the ebb current. If the wind is light and no steerage

* Named by Vancouver, 1792.

way on the vessel the feeling is decidedly disagreeable, especially as the current seems constantly to set close around Rock Duncan and Tatoosh island. If a vessel falls into the trough of this swell she is bound to fetch away something.

Settlers are gradually advancing from Puget's Sound and Admiralty Inlet along the strait westward, and seem destined to meet those coming up the coast from Gray's harbor and Shoalwater bay.

Washington Territory has a climate excelled only by that of California. We know not where to point to such a ramification of inland navigation, save in the British possessions to the northward. For depth of water, boldness of approaches, freedom from hidden dangers, and the immeasurable sea of gigantic timber coming down to the very shores, these waters are unsurpassed, unapproachable.

The Strait of Juan de Fuca was discovered by the long boat of the Imperial Eagle, under the command of Berkely, in 1787.

In June, 1788, it was examined by Meares, in the Felice, he having obtained information of its existence from Berkely. At the entrance it "appeared to be 12 or 14 leagues broad. From the mast-head it was observed to stretch to the E. by N., and a clear unbounded horizon was seen in that direction as far as the eye could reach." He frequently sounded "but could procure no bottom with 100 fathoms of line." He afterwards sent a party to explore the strait, who went up about 50 miles, determining the harbor of San Juan. He first applied the name "John de Fuca" to the strait.

After the expedition of 1775 several Spanish expeditions were fitted out for exploration in these latitudes, but we are not sufficiently acquainted with their results to state their claims and merits. Quimper was in the strait in 1790, and Galiano and Valdez in 1791 and 1792.

Gray entered the strait in 1792, penetrated 50 miles in an E.SE. direction, and found the passage 5 leagues wide. He gives the latitude of Tatoosh island, or Cape Flattery, 48° 24'. The extracts from his log-book, stating particulars of this and the Columbia river exploration, were not made public until 1816. All of Gray's latitudes, distances, and courses, are very good and trustworthy.

Vancouver entered the strait in 1792, and gave to the world the first detailed and authentic account of it.

THE SOUTHERN SHORE OF THE STRAIT OF JUAN DE FUCA.

NEÉ-AH BAY.

Koitlah Point, the western boundary of this bay, is 4 miles E. by N. ¾ N. from the light-house on Tatoosh island. From Cape Flattery the shore is nearly straight, high, and rugged, backed by hills about 1,500 or 2,000 feet high and covered with timber. Deep water is found within a third of a mile of the bluffs, and, at a distance of half a mile, a depth of 20 fathoms is obtained. Within a mile of Koitlah Point was a large village of the Mukkaws.

The bay is about a mile and a quarter long S.SE., and the same in width at the entrance. The western side is high, precipitous, and bordered by craggy, outcropping rocks 300 or 400 yards from the shore. The 3-fathom curve ranges about 600 yards from the foot of the bluff. The general direction of this side is SE. for one mile, when the hills suddenly cease and a low shore, with sand beach backed by woods, curves gradually to the NE. by E for a mile and a quarter to Ba-ad-dah Point, formed by a spur of the hills.

The east side of the bay is formed by Waaddah island, the northern end of which lies 1½ mile from Koitlah E. by N. ½ N. This island is a narrow, high ridge, about 250 yards wide and half a mile long, covered with trees, and having a direction SE. ¼ E. pointing toward Ba-ad-dah Point, and presenting the appearance of a continuation of that spur, but separated from it by a 4-fathom channel 500 yards wide. Off the southwest part rocks extend for 250 yards, and the 3-fathom curve is 600 yards distant. Along the sand beach the 3-fathom curve is within 200 yards of the shore, the depth increasing to 7 fathoms, then decreasing to 5 in the middle of the bay, and again increasing to 10 on the outer line of the bay. Much kelp abounds in this harbor, even in deep water; the lower and thinnest portion being used by the Indians for fishing lines. When coiled away and dry they break like glass, but soaking them in salt water renews their elasticity and strength.

The best anchorage is in the south part of the bay, in about 5 fathoms, being then off the small stream which comes in at the eastern foot of the hills. No direction can be given about anchoring off any particular village, as the Indians change their location so frequently; but near this stream will generally be found some houses, with an abundance of fresh water. During southerly weather little swell is felt here, and the wind can do no harm, but when a large westerly swell is coming up the strait it reaches here, and a vessel rolls uncomfortably unless she rides head to it.

The primary astronomical station of the Coast Survey was just back of the beach, about 400 yards east of the small stream before referred to. Its geographical position is:

	°	′	″	
Latitude	48	21	48.8	north.
Longitude	124	37	12.0	west.
	h.	*m.*	*s.*	
Or, in time	8	18	28.8.	

Magnetic variation 21° 30′ east, in August, 1852, with a yearly increase of 1′.4.

From the NW. end of Waaddah island it bears S. by W. ½ W., distant 1⅜ mile.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is XII*h.* XXXIII*m.* The mean rise and fall of tides is 5.6 feet; of spring tides 7.4 feet, and of neap tides 4.8 feet. The mean duration of the flood is 6*h.* 20*m.*, and of the ebb 6*h.* 6*m.* The average difference between the corrected establishments of the a. m. and p. m. tides of the same day is 1*h.* 18*m.* for high water and 1*h.* 2*m.* for low water. The differences when the moon's declination is greatest are 2*h.* 20*m.* and 1*h.* 56*m.*, respectively. The average difference in height of those two tides is 1.7 foot for the high waters and 3.5 feet for the low waters. When the moon's declination is greatest those differences are 2.8 feet and 5.0 feet, respectively. The average difference of the highest high and lowest low waters of the same day is 8.2 feet, and when the moon's declination is greatest 9.5 feet. The highest high water in the twenty-four hours occurs about 11*h.* 54*m.* after the moon's upper transit, (southing,) when the moon's declination is north, and about 32*m.* before, when south. The lowest low water occurs about 7*h.* after the highest high water.

This bay was known as Poverty cove by the early fur traders on the coast; next as Port Nuñez Guona, by Quimper, in 1790. In 1792 the Spaniards, then establishing themselves at Nootka Sound, attempted to found a colony here, and as late as 1847 bricks were found near the small stream abreast of the anchorage. We searched for vestiges of the settlement as late as 1852, but found nothing. Vancouver noted the indentation of the coast here in 1792. It was next called "Scarborough harbor," by the United States Exploring Expedition in 1841. The Indian name is that now adopted, and the only one by which it is known on the coast.

In 1852 the Mukkaws about Flattery could muster 300 or 400 warriors, mostly armed with muskets and knives. They had several large stockaded villages and hundreds of canoes. We have counted over 70 at one time fishing for salmon in the bay. They were brave and fearless; made voyages to Nitinat, Clayoquot, and Nootka Sounds, and pursued the whale and black fish successfully. In three months they sold over 7,500 gallons of oil to the traders. They maintain trade with the Indians on the west of Vancouver, forcing them to dispose of their oil and skins to themselves directly, and not to the traders. By this means they make a large profit as intermediate traders. They estimate their wealth by the number of slaves and blankets, and the quantity of oil they possess. In the fall of 1852 the smallpox was introduced among them, and nearly swept off the tribe—more than two-thirds falling victims to the disease—among them the principal chief, Clisseet, and the second chief, Flattery Jack.

Two miles east of Waaddah island, and within the limits of the kelp, is a rock 150 feet high, called Sail Rock by the United States Exploring Expedition, and by Kellet, Klaholoh, (seals.) The Indian name is Saelok. Behind it enters a small stream called the Okho on the Admiralty charts, but this is not the Indian name.

CALLAM BAY.

From the eastern point of Neé-ah bay to *Sekon Point*, the western part of Callam bay, the course is E. ½ S., and distance 13½ miles. The shore-line is nearly straight, bluff, and bordered by rocks, with an occasional stretch of sandy beach. One mile off shore the average depth of water is 20 fathoms. The bay is at the western termination of a high, bold, wooded ridge, running parallel to the shore, with an almost perpendicular water face, and falling away rapidly inshore. This easily recognized ridge is about 1,000 feet high and 7 miles long. The western extremity lies E. ½ S. from Waaddah island, is distant 16 miles, and called *Slip Point;* the eastern is designated as *Pillar Point.* The width of the bay from Sekon Point to Slip Point is 2 miles, and the bearing E. by N. ½ N. Outside these limits 15 fathoms water may be struck. The form of the bay is nearly semi-circular, and the depth of the curve nearly a mile, with 6 fathoms about the middle. Into it empties a small stream from the southeast, having low land on its eastern side, and a small rise on the west. Some sunken rocks are said to lie off Slip Point.

The water along the face of the ridge is very deep, and the bottom rocky and irregular. About half way along it is the entrance to a vein of lignite, which has been worked, but it is not fit for steamship consumption. Off this mine, at the distance of a cable's length, a depth of 35 fathoms is found, with a swell upon the rocks sufficient to destroy any boat loading there. The so-called coal is very easily broken, and crumbles by exposure to the weather. We saw it fairly tried upon a steamer, and it did not answer. An analysis of some of the best specimens yielded 68 per cent. of carbon, and we judge it to be bitumen. The geological formation of the whole region is opposed to the existence of coal. Among the bituminous shales we searched in vain for any specimens of fossil impressions.

Pillar Point is nearly E. ½ S. from the north end of Waaddah island, and distant 23 miles. Its latitude is 48° 13′ N. The peak is slightly separated from the main ridge by a depression. From this point the shore trends S.SE. about a mile, and receives a stream coming from the westward, called *Carrel river.* An Indian village exists here. The Indian name of the stream is Pisht-st.

From Pillar Point the next prominent object is a wooded hill called *Striped Peak*, bearing E. by N., and distant 17 miles. The shore retreats to the southward of this line about 3 miles, having alternate bluff and low shores, with many little streams opening upon them, and at the distance of 11 or 12 miles from Pillar Point, *Low Point* makes out at the mouth of a stream called the Lyre. Rocks abound close along the shore. The kelp generally extends out to 5 fathoms, and the average depth of water, a mile off, is 10 fathoms. One mile before reaching the western part of Striped Peak is a sunken rock, upon which the sea breaks at low water. A slight indentation of the shore here has received the name of *Crescent bay.*

Striped Peak is several hundred feet high, and wooded; and was doubtless named from a well marked line upon its water side, occasioned by a land slide from its summit. This mark is being rapidly obliterated by the growth of vegetation. The base of the hill towards the water presents a straight line, running E. by N. for 3 miles, with deep water off it.

Freshwater bay.—The eastern part of Striped Peak, with several rocks off it, is called Observatory Point on the Admiralty charts, and forms the western boundary of Freshwater bay. The eastern side is the low delta called Angelos Point, at the mouth of the river Elwha, and the line joining the two runs E. by N. $\frac{3}{8}$ N. 3 miles across. Inside of this line the depth of the curve is about $1\frac{1}{4}$ mile, with water ranging from 16 fathoms to 4 and 5 close in shore. The western shore of the bay is bluff, the eastern low, with bluff in the rear. The waters of the Elwha bring down such quantities of earth that we find only 10 fathoms water at a distance of three-quarters of a mile off its mouth.

PORT ANGELES OR FALSE DUNGENESS.

Four miles east of the Elwha commences a long, low, very narrow sand spit, stretching out from the bluff in a general E.NE. direction for 3 miles, to the point called *Ediz Hook*, which lies $1\frac{1}{2}$ mile off the main shore, thus forming an excellent and extensive harbor, with deep water of 25 to 30 fathoms, sandy bottom, close under the inside of the sand spit, almost to the head of the bay. Through the centre of the bay we found a line of 15 fathoms, sticky bottom, and between that and the main it shoals very regularly with the same kind of bottom. On the outside of the spit very deep water is found close to it, and the hook may be rounded within a cable's length in 25 fathoms. In the indentation between Angelos Point and the head of the bay the water is shoal, 10 fathoms being found 2 miles from shore.

The Hook is covered with coarse grass, and in many places with driftwood, showing that the sea sometimes washes over it. Although it lies well out of the line of vessels bound either in or out of the strait, it would be advisable to mark it with large, easily recognized beacons, or to plant trees along part of it, as it cannot now be distinguished, even in good weather, until a vessel is close upon it. From the middle of the strait it cannot be made out unless the appearance of the bluff beyond is known. At the head of the bay is a large salt water lagoon. Fresh water is found on the south shore is several places, but the extensive flats render it hard to obtain. The bluff, 70 feet high, comes directly to the high water line, and is covered with trees. Three Indian villages of the Clallums existed on its shores in 1852, when a secondary astronomical station of the Coast Survey was established near the Indian graveyard at the head of the harbor. It geographical position is:

	°	′	″	
Latitude	48	07	52.0	north.
Longitude	123	27	21	west;
	h.	*m.*	*s.*	
Or, in time	8	13	49.4.	

From this station the extremity of Ediz Hook bears NE. by E., distant $2\frac{5}{8}$ miles.

The bay was first discovered by the Spaniards, and by them made known to Vancouver in 1792. We first heard of its present name, False Dungeness, in 1852, when at Cape Flattery, from traders there. A preliminary chart of False Dungeness was published by the Coast Survey in 1853, and a second edition in 1856.

NEW DUNGENESS BAY.

The shore from Point Angeles gradually curves to the northeast, and about 8 or 9 miles from Ediz Hook another long, low, narrow sand spit, covered with grass, leaves the bluff shore and stretches in a general N.NE. direction for $3\frac{7}{8}$ miles, forming the northwestern side of the roadstead of New Dungeness. On the inside, one mile from the eastern extremity, another narrow sand spit makes $1\frac{1}{3}$ mile southward towards the main shore, forming a large inner shoal bay, with a narrow opening, through which the water passes as over a rapid at low tide. Abreast of this point is a small stream, affording an abundance of fresh water, but boats must obtain their supply at low tide, and come out when the tide has sufficiently risen. The western side of this stream is a bluff 60 feet high, and upon it is a large village of the Clallums. The eastern shore of the stream is low, swampy, and covered with trees and brush. It forms the southern or main shore of the roadstead, and off it lie extensive mud flats, which are bare at low water for five-eighths of a mile, and run as far as Washington, or Budd's harbor. Shoal water exists some distance outside of these flats. About 20 fathoms are found a quarter of a mile south of the Light-house Point, the depth regularly decreasing across the bay, with a soft, tenacious, muddy bottom. The usual and best anchorage is to bring the light-house to bear about N. by E. $\frac{1}{2}$ E., half a mile distant, when 10 fathoms are found one-third of a mile, broad off the beach. With the light-house bearing NW. by N. three-quarters of a mile distant the same depth and bottom are found. The nearest shore will bear south $1\frac{1}{4}$ mile, and the mud flat three-quarters of a mile in the same direction. A southeast wind drawing out of the strait blows directly into this harbor, but the bottom will hold any vessel with good ground tackle. The only difficulty will be to get the anchors out of the mud after riding a couple of days to a gale. In the last position a vessel can readily get under weigh and clear the point.

This point is so low that vessels bound in or out, before the erection of the light-house, were upon it before they were aware of their danger. Several had run ashore on the outside beach, and in 1855, while we were anchored close in, with the weather thick and hazy, a vessel from Admiralty Inlet had been set out of her course by the currents, and came driving in with studding sails out, and only saw her mistake and danger when the black hull of our vessel attracted her attention.

A shoal with $2\frac{1}{2}$ fathoms makes out N.NE. from the end of the point for half a mile, and a heavy tide-rip runs over it at the change of the currents.

A hydrographic sketch of New Dungeness was issued from the Coast Survey office in 1856.

LIGHT-HOUSE AT NEW DUNGENESS.

The structure is about one-sixth of a mile from the outer end of the point, and consists of a keeper's dwelling of stone, with a tower of brick; the upper half being a dark lead color, the lower half white. The tower is surmounted by an iron lantern painted red; the entire height being 92 feet, and its elevation above the mean sea-level 100 feet.

The light was first exhibited December 14, 1857, and shows every night, from sunset to sunrise, a *fixed white light* of the third order of Fresnel, which should be seen from a height of:

10 feet at a distance of	15		miles.
20 "	"	$16\frac{1}{2}$	"
30 "	"	$17\frac{3}{4}$	"

Its geographical position, as determined by the United States Coast Survey, is:

	°	′	″	
Latitude	48	10	59	north.
Longitude	123	06	07	west.
	h.	*m.*	*s.*	
Or, in time	8	12	24.5	

Magnetic variation 21° 43′ east, in August, 1856, with a yearly increase of 1′. 4.

From it we have the following bearings and distances:

Striped Peak SW. by W. $\frac{1}{2}$ W.,	distant	21	miles.
Race islands west,	"	18	"
Victoria Harbor NW. by W. $\frac{3}{4}$ W.,	"	$17\frac{3}{4}$	"
Smith's island NE. by N. $\frac{1}{3}$ N.,	"	13	"
Point Wilson E. by N.,	"	$14\frac{3}{4}$	"

Fog-bell at New Dungeness.—Upon the outer extremity of the point a fog-bell of 1,100 pounds weight has been placed, and will be sounded every ten seconds during foggy or other thick weather day and night. "The striking machinery is in a frame building, with the front open, to receive the bell, painted black, raised 30 feet above the ground on an open structure, white-washed."

Tides.—The approximate corrected establishment is III*h.* III*m.* and the approximate mean rise and fall of tides 5.0 feet.

Our experience in these waters suggests that the light-house building should be painted black, or a color most readily made out in foggy or smoky weather. Several years since we urged the advantage of planting trees along the spit to afford large dark masses, that a lookout might see the danger before being upon it. A few settlers are now located about the bay.

This harbor was first examined and made known by Vancouver, who applied the present name, in 1792. It is known by no other.

Eastward of Dungeness the shore is indented by Washington harbor, Port Discovery, and Admiralty Inlet, the northwest point of the entrance to which is Point Wilson.

WASHINGTON, OR BUDD'S HARBOR.

From New Dungeness roadstead to the entrance to this harbor the immediate shore is low, flat, covered with trees, and bordered by an extensive mud flat; but behind it, at a very short distance, rises a level plateau. The bluff at the NE. point of the harbor is seen from Dungeness Point. The entrance of the harbor is nearly closed by a low sand spit stretching across it from the east, almost to the western part, where a narrow channel way exists having two fathoms through it. This cannot be seen from Dungeness Point, which is $6\frac{1}{2}$ miles NW., on account of the outward curving of the intermediate shore. Inside of the harbor we found 17 fathoms. Its width is a little over a mile, and regular, its length about 3 miles, and the general direction SE. by S. One mile outside of the sand spit a depth of 10 and 12 fathoms exists, deepening rapidly to 30 and 35, with a bottom of stiff mud.

This harbor was surveyed first by the United States Exploring Expedition, and called Budd's harbor, but there being a sheet of water in Puget's Sound bearing a similar name, we have adopted Kellett's appellation. The Indian name of the bay is S'quim, by which it is generally known to the settlers.

Quimper, in 1790, explored the harbors about here, as did Galiano and Valdes in 1791.

PROTECTION ISLAND.

The western extremity of this island lies E. $\frac{3}{8}$ S., distant $7\frac{1}{2}$ miles from Dungeness lighthouse, and extends a little over a mile E.NE., being narrow, curved outward to the strait, and having a low point at each end, with shoal water stretching from the western. Its sides are very steep, and about 200 feet high, the seaward part covered with timber, and that towards Port Discovery undulating and covered with fern. It lies two miles directly off (NW.) the entrance to Port Discovery. On the inside is found very deep water, but upon the outside a line of kelp, about half a mile out, marks the 4-fathom curve, and from this a bank runs out N.NW. for three miles, having from 5 to 15 fathoms upon it, with a shoal spot of 3 and 4 fathoms two miles from the island. It affords a good anchorage with light airs and strong adverse currents. The bottom is irregular and falls off suddenly.

This island, with Port Angeles and New Dungeness, afford the first examples of the peculiar feature of low sandy and gravelly points covered with coarse grass and bushes, making out from the high cliffs, where the tendency of strong currents would seem to be to cut them off.

It was called Protection island by Vancouver in 1792, and on account of its position in relation to Port Discovery, is very aptly named.

PORT DISCOVERY.

From Dungeness light the west side of the entrance to Port Discovery, called Challam Point, bears E. by S. $\frac{1}{5}$ S. distant 9 miles. From Washington harbor the distance is 4 miles. The intermediate shore is composed of high steep cliffs. Cape George, the eastern point of the entrance, bears NE. about $1\frac{1}{2}$ mile from Challam Point, and this is nearly the uniform width of the bay for its entire length of 9 miles. It makes three or four courses from the entrance to the head, as follows: 2 miles S. $\frac{3}{4}$ E., 3 miles E. by S. $\frac{1}{2}$ S., 2 miles S. by E. $\frac{1}{2}$ E., and 2 miles SW. $\frac{3}{4}$ W. These data and the names of points are taken from the Admiralty chart, as we have not the map or notes of our survey before us. The shores are abrupt and covered with wood to their edges, and the projecting parts are all terminated by low points stretching out short distances. On the second point on the eastern side were (1856) the remains of an extensive stockaded village of the Clallums. Mount Chatham lies off the southwestern part of the bay, and reaches a height of 2,000 feet.

When well in this bay Protection island so completely shuts up the entrance as to make it appear as a large lake. The great drawback to this port is its depth of water, which in mid-channel is not less in any place than 25 fathoms, and in some is 40. Under the second low point on the east we could not find less than 25 fathoms a few ship's lengths from the beach, but found good anchorage in 20 fathoms, soft bottom, on the western shore 2 miles S.SE. from Challam Point, and abreast of a low swampy beach. At the head of the bay it contracts in width, the water shoals, a large mud flat exists for the last mile, and the shores become higher, but in places the hills retreat and give a scanty space for a few settlers' cabins. For a few years after the settling of San Francisco many vessels came here for piles and spars.

It was discovered in 1790 by Quimper, and called port Quadra. In 1791 the Spanish discovery brig Sutil, Señor Don D. Galiano, and the schooner Mexicana, Señor Don C. Valdez, refitted their ships here.

It was first surveyed and made known by Vancouver in 1792, who refitted his ships and established an observatory at the second low point on the western shore. He gave it the present name, after one of his ships, and it is known by no other.

In 1856 we found on the bluff back of Challam Point great numbers of trees that had been twisted off and uprooted by a tornado from the southeastward. The prostrated trees were plainly visible on the sloping hill side from the bay.

Point Wilson is the western point of the entrance to Admiralty Inlet. From Dungeness light it bears E. by N., distant nearly 15 miles; this course passing over the outer edge of the 3-fathom shoal off Protection island. The extremity of the point is composed of low sandy hillocks covered with coarse grass; but west of it the hill rises 200 or 300 feet, and again falls inshore. This appearance is well seen in approaching it from the strait, and is a good mark. Between the point and Port Discovery the shore is high with steep yellow cliffs, and about midway a slightly projecting angle is formed, called Middle Point. To the northwest of the point 15 fathoms can be obtained a mile from the shore, but the water shoals suddenly, and in running in a fog the lead must be kept going. Off the eastern end of the point 20 fathoms can be got a ship's length from shore. During ebb tides a very strong eddy current sets eastward along shore between Discovery and Point Wilson. In 1855, when coming out of the inlet on the large ebb, with scarcely any wind, we kept outside of the rip showing the line of the eddy. A vessel two or three miles ahead was in the eddy at the same time. We were carried past Protection island, but she was drifted back to Point Wilson. The Indians when bound to Dungeness keep well out in the ebb.

A light-house has been recommended for this point, as it presents many advantages over the head on the opposite side of the inlet.

When we were last there (1857) a small unfinished log hut, called Fort Mason, stood upon it. It received its present name from Vancouver in 1792.

VANCOUVER ISLAND.

NORTH SHORE OF THE STRAIT OF JUAN DE FUCA.

From Point Bonilla to Owen Point, forming the western head of the entrance to Port San Juan, the shore runs 13 miles E. ½ N. It is nearly straight, rocky and bluff, with high mountains rising immediately behind it, and all heavily wooded. From 10 to 20 fathoms are found within half a mile from the shore. Vessels are apt to lose much of the wind when close under either shore, and at present it is impossible to say where the strongest currents run.

PORT SAN JUAN.

The eastern head of the entrance is formed by several large rocks called Observatory Rocks on the Admiralty chart of 1847. From Tatoosh island light they bear NE. by N. ¼ N., 14 miles distant. The width of the bay is 1¾ mile from point to point, and their bearing E. ¼ S. and W. ¼ N. from each other. The length of the bay is 3½ miles on a general course NE. ¾ N., and the width almost uniform at 1¼ mile to the very head, where several streams enter, amongst which are Cooper inlet at the northeast, and the river Gordon at the north, where stands a large Indian village, called Onismah. Across the entrance a depth of 10 fathoms is found, except near Observatory Rocks, where 17 exists close to them. Outside we find from 15 to 20; and inside the bottom is very regular in 7 to 10 fathoms, up to the head, where it decreases evenly to 4 within half a mile of the shore. The eastern side has the least number of rocks and a mid-channel course clears every thing well. In heavy southerly weather a swell rolls straight in, but by anchoring well up on either side vessels avoid it. The sides are steep, high, and backed by heavily timbered hills and mountains. At a distance in very clear weather it is difficult to distinguish the entrance unless one is acquainted with the locality, but in moderately hazy weather the indentation is readily made out.

The approximate position of Observatory Rocks is:

	° ′ ″
Latitude	48 31 30 north.
Longitude	124 28 15 west.

Meares first noted this bay in his map, and called the western point Point Hawksbury. He called Bonilla Point Point Duffire, after his first officer. It was afterwards examined by the Spaniards, and Vancouver stretched over to this shore and plotted it on his chart. It was surveyed by the United States Exploring Expedition in 1841, and by Kellett in 1847.

From Observatory Rocks the shore preserves the same features, running east in a straight line to *Sheringham Point* 23½ miles, with soundings in from 6 to 20 fathoms a mile from shore, and in some places 10 fathoms at least 2 miles off, then suddenly dropping into 50 and 60 fathoms. From Sheringham on an E. ½ N. course to *Otter Point* the distance is 4½ miles, with a curve in the shore of one mile, but the shore is generally so uniform in its character that it is hard to recognize these points in sailing close abreast of them.

SOOKE INLET.

From Sheringham Point to *Beechy Head* the distance is 11½ miles, and course E. ¼ N. The shore is varied by an indentation one mile deep, called Sooke bay, and at a distance of 4 miles from Otter Point is broken by a very narrow, crooked entrance, which is Sooke inlet. This leads to a large sheet of water 3 miles inland, called Sooke basin. One mile east of this inlet is a large islet called Secretary island, and on the western side is a bright yellow bluff, from which makes out a low sand spit, NE. for half a mile across the entrance. To the eastward of this spit is the passage, only 100 or 200 yards wide, with an irregular and rocky bottom and some sunken rocks. The currents run through with great velocity, and a thorough knowledge of these and the channel is necessary to enter this place. When a depth of 10 fathoms is struck off the entrance a high hill called Mount Maguire will bear about NE. It is partially covered with trees, but the bare rock shows distinctly in many places, and this feature now commences to distinguish this part of Vancouver island round its southeast portion. The shore in many places is bare and rocky, with patches of land covered with fern and destitute of trees, and the houses of settlers begin to appear.

Off Beechy Head the water is very deep and the currents go by with a rush. In this vicinity we recollect the instance of a cutter striking the bold shore with her flying jib-boom, and only striking her forefoot after the jib-boom had been carried away.

The approximate geographical position of Beechy Head is:

	° ′ ″
Latitude	48 18 30 north.
Longitude	123 39 27 west.

The pronunciation of Sooke is exactly like that of the English word "soak." The Indian word is T'sōk.

Beecher bay lies to the eastward of Beechy Head. Its general direction is north for about a mile and a half; width about the same, and the bottom is rocky and irregular, with deep water. Many rocky islets are found upon the eastern side of the bay, and two large ones at the northern part. The channel runs between these with about 20 fathoms, and with from 7 to 10 fathoms beyond the eastern one. The eastern head is formed by *Cape Church*. This bay is enclosed by high, rocky hills.

RACE ISLANDS.

From Beechy Head the outermost of these islets bears E. by N., distant 5 miles, and its distance from Bentinck island, close under the main shore, is one mile. This cluster of islets numbers about ten principal ones, which cover an area of not less than half a mile square. They are low, and the larger ones are covered with grass, but are without trees or bushes. Stretching SE. for half a mile, the bottom is irregular, with points of rock in 5 fathoms. The currents rush by with great velocity and irregularity, attaining a rate of 6 miles per hour. This is a hard place for sailing vessels when the airs are light.

The approximate geographical position of the eastern islet is:

Latitude	48° 17½′ north.
Longitude	123° 32′ west.

It is of the utmost importance that a light-house should be established here at an early day. A glance at the map will demonstrate this without calling in the aid of local knowledge on the subject.

From Race islands the strait opens to the northward, and we have the following bearings and distances to several important positions:

Entrance of Esquimault harbor, north	8½ miles.
Entrance of Victoria harbor, N. by E. ½ E	9 "
Trial islands, NE. by N	10½ "
Discovery island, NE. by N	15 "
New Dungeness light, east	18 "

From Race islands the shore is very much broken to Esquimault harbor, first by a narrow, deep indentation called Pedder bay, its northern point called William Head; then Parry bay and Albert Head, and just before reaching Esquimault a long, low spit with a salt lagoon behind it. Along this shore the ebb current runs with great strength, the water being from 40 to 50 fathoms deep, and the general set on the Race islands.

Esquimault harbor is the bay where all the British men-of-war lie. It is in the deepest part of the large indentation called Royal bay. The entrance is a quarter of a mile wide, and has two rocky heads on either hand, the western having Fishguard island off it, and the eastern outlying sunken rocks south of it, with several islets. From the entrance the general direction of the bay is N.NW., and the extreme length two miles. After passing the heads the harbor opens to the east, forming a beautiful small bay, where men-of-war anchor in an uniform depth of 6 fathoms. In the entrance are 7 and 8 fathoms, and the approaches for a mile give from 10 to 13 fathoms.

The approximate geographical position of Fishguard island is:

Latitude	48° 25′ 38″ north.
Longitude	123 27 10 west.

At the head of the harbor is Mount Seymour.

Five miles west of the head of Esquimault bay is the head of a large bay coming from the north, and opening into the inside channel to the Nahny'moh coal mines.

VICTORIA HARBOR.

The entrance to this harbor is $2\frac{1}{4}$ miles east of Esquimault. As the channel is very contracted, crooked, and obstructed with a 10-feet bar, vessels usually anchor outside in 10 or 15 fathoms, taking care to avoid *Brotchy ledge*, with only 7 feet water upon it, lying about half a mile S.SE. of the eastern head and SW. $\frac{3}{4}$ W. from Mount Beacon, upon which was a range with one on the shore. We believe, however, that the ledge has been marked by a spar buoy since our visit there. The channel inside is well marked out by buoys, but a pilot is necessary to carry a vessel in. The whole length of the harbor is about 3 or 4 miles, with an average width of one-fifth of a mile. It is very tortuous, and the head stretches west nearly to the head of Esquimault bay, where a portage exists.

The approaches to the harbor are deep outside of Brotchy ledge, and from 20 to 10 fathoms are found inside of it.

The approximate geographical position of Mount Beacon is:

	°	′	
Latitude	48	$24\frac{1}{2}$	north.
Longitude	123	$22\frac{1}{4}$	west.

The Hudson Bay Company have a flourishing settlement and trading establishment a mile and a half within the entrance, and much of the surrounding country is well cultivated, but the settlement hereabout must spread toward Esquimault, or upon that harbor, not only on account of its superior excellence, but because fresh water is scarce about Victoria.

The shores are comparatively low, but rocky, and covered in part by trees, reminding one of the rocky parts of the coast of Massachusetts and New Hampshire.

TRIAL ISLANDS.

These islands lie 4 miles E.SE. from the entrance of Victoria harbor, with a rocky, irregular, and moderately low shore. The islands are small in extent, and the currrents set by them with great velocity.

DISCOVERY AND CHATHAM ISLANDS.

The former of these two islands lies $2\frac{1}{2}$ miles off the southeast point of Vancouver island. It is about a mile in extent, 230 feet high, partially covered with trees, and consists of granite rock, which shows in places without a particle of vegetation.

Northwest of it and separated by a narrow and intricate channel full of rocks lies Chatham island, (composed of several small islets,) somewhat smaller in extent, and not so high as Discovery island, but similar in appearance and formation. Between these two islands and Vancouver lies an extensive bay nearly filled with rocks and reefs, the main body being called the Chain islands. Close around the western side of Discovery and Chatham is a channel, having from 7 to 17 fathoms; but it is only fit for small craft. From the western part of Chatham to Codboro' Point the distance is about three-quarters of a mile. Numerous rocks show close to the point.

The approximate geographical position of the centre of the island is:

	°	′	
Latitude	48	26	north.
Longitude	123	14½	west.

A light-house is much needed upon Discovery island, as marking the southwest point of the southern entrance to the Canal de Haro.

The islands were named by Kellett after Vancouver's two ships.

ARCHIPELAGO DE HARO.

CANAL DE HARO.

The southern entrance to this strait may be said to lie between Discovery island and the point of Bellevue or San Juan Island, nearly northeast and 7 miles distant. Starting from this line and about three miles from Discovery, a course NW. by N. for 16 miles will run through the first stretch of the strait; thence an abrupt turn is made towards the eastward, and the way out can be readily seen between the islands. The next course is NE. ½ E. for 11 miles; finally, N.NW. 2½ miles, and a run of 7 miles on that course will carry a vessel into the middle of the Gulf of Georgia.

Commencing at the starting point, we have Bellevue island on the eastward and pass it at the distance of 1½ mile. Its mountains rise to 1,070 feet, and some of them are only partially covered with wood. The bluffs are very precipitous and inaccessible, and the depth of water close to them is as much as 150 fathoms. The greater extent of the strait is to the westward, stretching off into bays and passages among the islands. *Cordova bay* is the only available anchorage about this entrance. It commences at Gordon Head, 5½ miles NW. by W. ¼ W. from Discovery island; then stretches westward for 2 miles, and gradually curves to the N.NW., with a long high bluff, broken and bright, at *Cowichin Head.** Back of the southwest part of the bay rises a bold rocky-topped hill, (called *Mount Douglas* by the Coast Survey parties,) which reaches a height of 690 feet. Fresh water is obtainable on the southern shores of the bay. The northern limit of the bay is *Darcy island*, N. ¼ W. 4 miles from Gordon Head, and on this course and 1¾ miles from the Head is *Zero Rock*, a small white rock, showing a few feet above water, with plenty of water around it, but foul bottom and a patch of kelp a few hundred yards N.NW. of it. A mile and a quarter west of it is a sunken rock. In the bay a depth of not over 20 fathoms is found, decreasing irregularly in advancing, but in the southern portion affording capital holding ground in 10 fathoms. A mile and a half E.SE. from Gordon Head are patches of kelp and foul bottom

When 8½ miles within the entrance the width of the strait decreases to 3½ miles, having Darcy island (low and wooded) on the west, with a small islet off its NE. face, and very large fields of kelp stretching far off the southeast point into the Canal. In one of these fields we discovered in 1853 a sharp pointed rock, which has been called *Unit Rock*, lying N. 72° E. from the SE. point of Darcy island, and distant from it three-quarters of a mile. The small sharp apex of this rock rises about three feet above the very lowest tides. In the most recent charts deep water is placed around it, and when the coast surveying brig beat through the field the existence of this danger was unknown. Near mid-channel a depth of 155 fathoms is found.

* The Indian name for the tribe in this vicinity.

The island to the eastward, nearly abreast of Darcy, with a small cove at its southern end, is *Henry island** having a high, rocky precipitous front, and a swirling current around it. Further on and to the westward is the southeast end of *Sidney island*, 1½ mile northward of Darcy with the Dot Rocks between them but nearer Sidney. This island is not high like those on the other side of the channel, and a landing is easily made at any point. The channel here, 10 miles from the entrance, is 2¾ miles wide. To the eastward it opens beyond the north end of Henry island, with high mountainous islands bounding the view. To the westward lie a couple of long narrow islands a mile from Sidney, and between them and the latter is good anchorage and capital fishing ground for halibut. The moderately low wooded islands 3 or 4 miles ahead, and on the western side of the channel, have not been named. Between them runs the inside channel for steamers to the Nahnymoh coal mines. The background of the view is occupied by wooded islands, overlapping each other and appearing like a continuous shore. The large high island on the eastern side, 15 miles from the entrance is *Stuart island*,* and the Canal is here contracted to a breadth of only two miles, this being the narrowest part. In this pass no bottom was found with 165 fathoms of line. Stuart island in many places is very high and precipitous, and covered with timber, but in some parts sparsely. Near its southwest head a perpendicular wall of rock serves also to distinguish it. After passing the western end of this island at the distance of a mile, the channel takes an abrupt turn to the eastward, and the Gulf of Georgia is seen. The course now is NE. ½ E. for 11 miles, having on the northwest side *Saturna island*, which rises into mountains. *Java Head*,* near its eastern extremity, stands up perpendicularly many hundred feet, but the extreme part, called *East Point*,* is a long sloping point, in many places destitute of trees. The small island lying off its north shore is Tumbo.*

On the east side the waters open well to the southeast, and the islands rise in high hills and mountains. The large island abreast of Java Head is Waldron,* which has good anchorage off its southwest side, where the shore-line curves well in. The western point is low and sandy; the southern, called *Point Disney*,* is perpendicular, high and rocky. Off its northern face lie two islets, called *Skipjack islands*.* The western one is about a mile from Waldron, moderately high, and wooded; the eastern is smaller, about 40 feet high, destitute of trees, but covered with grass, and lies a mile east of the former. Between these lies a sunken rock, and the current rushes by with great velocity.

On some recent maps two islands, called Adolphus and George, are laid down close to the Skipjacks, but in 1853 we examined the vicinity and satisfied ourselves that they did not then exist.

When East Point bears NW. by W. ¾ W. 2 miles distant, the west end of *Patos island*,† will bear N.NE. 2½ miles, and the west end of the *Sucia Group*,† E.NE. 3½ miles; the course out lying N.NW. between Patos and East Point, which are 2¾ miles apart. Seven miles on this course carries to the middle of the Gulf of Georgia.‡ Close off East Point is found a depth of 120 fathoms, and off Patos island 170 fathoms. All these islands are moderately high and covered with wood. They are rugged and irregular, composed of sandstone and conglomerate, upheaved until the strata are nearly perpendicular in some places, and interspersed with small veins of lignite.

* Named by the United States Exploring Expedition, 1841.
† Old Spanish name.
‡ Named by Vancouver in 1792.

The approximate geographical position of two or three points will serve to check the courses above given:

East point of Discovery island—latitude 48° 25′ N., longitude 123° 14, W.

West point of Stuart island—latitude 48° 41′ 17″.5 N., longitude 123° 14′ 29″.6 W.

West point of Patos island—latitude 48° 47′ 03″ N., longitude 122° 57′ 31″.2 W.

The number of islands and the intricate channels lying between the two straits we shall not attempt to describe. A proper appreciation of them can only be obtained from the chart. The position of the islands are shown on sketches issued from the Coast Survey Office in 1854 and 1858.

Returning to the Strait of Fuca to enter the Rosario strait, we notice, first, *Smith's island*, lying at the eastern termination of the Strait of Juan de Fuca, within 6 miles of Whidbey island and 7 miles broad off the southern entrance to the Rosario strait. It is quite small, not occupying half a square mile, and rises regularly from the eastern to the western extremity, where it attains a height of about 55 feet, with an almost perpendicular cliff of clay and gravel. It sustains a few dreary looking trees, but none of great thickness or height, and the surface is covered with a growth of bushes ten or twelve feet high. There is no fresh water to be found on the island, and two or three feet below the surface is a stratum of hard dry clay with pebbles.

A very small, low islet called *Minor*, exists one mile northeast of Smith's island, and at very low tides is connected with it by a narrow ridge of boulders and rocks. A field of kelp extends to the westward for 1½ mile, and has a width of a mile. In sailing through this field we found the depth of water very uniform at 6½ fathoms, and in no place did we get less. The bottom is hard and sandy. Another smaller field is seen to the westward of the one just mentioned. Good anchorage is found on the north side of the island, east of the kelp, in from 10 to 5 fathoms, and on the south side, east of the kelp, in from 10 to 8 fathoms, hard bottom. We parted our cable here in a southeast gale, but the smooth sandy bottom enabled us afterwards to secure the anchor. Off the eastern end of the small islet very deep water is found close to it.

The light-house on Smith's island is a structure consisting of a keeper's dwelling, with a tower rising through it, and surmounted by an iron lantern painted red. Its height is 41½ feet above the surface of the ground and about 90 feet above the mean level of the sea. The dwelling and tower are plastered and whitewashed, and situated on the highest part of the island, near the southwest point. All the trees have been cut down, to afford a clear horizon in every direction. The illuminating apparatus is of the fourth order of Fresnel, shows a *revolving white light, with a flash every half minute*, and should be seen from a height of—

10 feet	at a distance of	14½	miles.
20	"	"	16	"
30	"	"	17	"

It was first exhibited on the 18th of October, 1858, and shows from sunset to sunrise.

The approximate geographical position of the light, as determined by the Coast Survey, is:

	° ′ ″
Latitude	48 19 11 north.
Longitude	122 50 01 west.
	h. m. s.
Or, in time	8 11 20.1

The light shows into the entrances of Canal de Haro, Rosario strait, and Admiralty Inlet, and out into the Strait of Juan de Fuca.

The following bearings and distances will show the relative position of Smith's island:

From Discovery island it lies	East	$16\frac{1}{2}$ miles.
From New Dungeness light-house	NE. by N.	$13\frac{2}{3}$ "
From Point Wilson	NW. $\frac{1}{2}$ N.	11 "
From southwest point of the entrance to Rosario strait	S. $\frac{1}{2}$ E.	$6\frac{2}{3}$ "

On the maps of the United States Exploring Expedition it is called Blunt's island; but it is now known by the name we have used, which is also that given on the Admiralty charts.

Fields of kelp.—Three miles S. $\frac{1}{2}$ E. of Smith's island is a field of kelp over a mile long by a mile wide. Through it the soundings range from 6 to 12 fathoms, and the bank stretches off to the E.SE. for two miles, with 10 and 12 fathoms upon it. This locality requires sounding out, as it would prove a great advantage for vessels drifting at the mercy of the currents to know of the existence of such anchoring grounds. The detailed hydrography of all this sheet of water eastward of the Race islands will develop many interesting features of bottom.

Bearing W. $\frac{1}{2}$ S. from Smith's island, and eight miles distant, is another field of kelp nearly a mile in extent. We came unexpectedly upon it at night, in 1854, during a heavy blow, with rain. It was not then marked on any chart. Next morning we sounded through it, and found the depth of water very uniform at 5 fathoms.

The field laid down on the Admiralty chart—nearly on this course, and four miles from Smith's island, having only 2 fathoms marked upon it—has been sought for, but not found.

One mile south of the southeastern point of Bellevue island, and $8\frac{1}{2}$ miles NW. by W. $\frac{1}{4}$ W. from Smith's island, lies a small field of kelp about half a mile square, with 3 fathoms marked upon it; but we have been informed that the Hudson Bay Company's steamer Otter found as little as 6 feet of water with its limits.

All these fields and patches of kelp should be avoided, as they denote rocky bottom; and isolated points of rocks frequently exist among them and escape even a very scrutinizing survey.

Shoals.—E. by N. $5\frac{1}{2}$ miles from Discovery island, and S. by W. $\frac{1}{3}$ W. $4\frac{1}{2}$ miles from the Hudson Bay Company's settlement on Bellevue island, is an 11-fathom shoal a mile or two in extent; but the very few soundings upon it leave the precise extent and smallest depth of water doubtful.

NE. $\frac{1}{2}$ N. $7\frac{1}{2}$ miles from Race islands, and SE. by S. 4 miles from the entrance to Victoria harbor, are a couple of spots showing 13 and 14 fathoms.

Off Point Partridge* (the western head of Whidbey island) is a 10-fathom bank, with muddy bottom. We have run across it and found this depth, but the locality has not been sounded out.

ROSARIO STRAIT.

This is the eastern of the two principal channels running through the Archipelago de Haro, between Vancouver island and the main. Its southern entrance lies N. by E., distant 7 miles from Smith's island, and is $4\frac{1}{4}$ miles wide. The western point of the entrance is formed by a point running out from *Watmough Head*,† which is 450 feet high and on the southeast part of *Lopez island*. Off this point lie several rocky islets, with deep water among them and a rushing current. The outer, or southeast island, is about 50 feet high, rocky, flat-topped, destitute of bush or tree, narrow, and about one-third of a mile in length, east and west. S. 83° E. from

* Named by Vancouver, 1792.

† Named by the United States Exploring Expedition, 1841.

it, at a distance of half a mile, lies *Entrance Rock*, possibly bare at the lowest tides. A patch of kelp exists upon and around it, but the kelp is generally run under the surface of the water by the strength of the current. We discovered this rock in 1854.

The whole southern face of Lopez island is guarded by rocks and reefs. The island itself is very rocky and moderately low.

On the eastern side of the entrance is a small wooded islet called Deception island, at the mouth of *Deception pass*;* an intricate and very narrow 3-fathom channel, 3 miles long, running between the north end of Whidbey island and the south end of *Fidalgo island*. In 1841 the United States brig Bainbridge passed through it from the eastward. It is the Boca de Flon of Quimper, 1790, but is now known only by the apt designation given above.

In the middle of the entrance to Rosario strait Vancouver anchored in 37 fathoms, black muddy bottom, in 1792.

When at the entrance, and $1\frac{1}{4}$ mile from the western side, a line will pass clear of everything from one end of the strait to the other. This course is N. by W. $\frac{1}{2}$ W., distant $19\frac{1}{4}$ miles to the north entrance. It passes between Bird and Belle Rocks, and almost tangent to Point Lawrence, on Orcas island. Taking the courses through the mid-channel we should have the following: NW. by N. $\frac{3}{8}$ N. for $11\frac{1}{4}$ miles; N. by E. $\frac{3}{4}$ E. for $3\frac{3}{4}$ miles; and NW. $\frac{1}{2}$ W. for $6\frac{1}{4}$ miles—making a total of $20\frac{1}{2}$ miles.

The first two miles on the western side is moderately high, declining to a point, a quarter of a mile off which lies Kellett's ledge, bare at the lowest tides, and having deep water all around it. The ledge is marked by a mass of kelp. Thence the shore makes a deep bend for a mile to the westward, with a low beach and marsh, over which *Lopez bay* can be seen. This bend is called *Shoal bight*, and has from 6 to 10 fathoms for a mile out, with level sandy bottom. In mid-channel rise the *Bird Rocks*,* about 40 feet high, consisting of three small rocky islets very close together, and running in a north direction. They are somewhat pyramidal in form, and during the summer show yellowish, on account of the parched grass and the color of the rocks. Abreast of them, on the western side, is a narrow opening between two low rocky heads of Lopez and *Decatur islands*.* Inside is a line of islets ranging from the north head, and making the channel run towards the south. This barrier is called the Lopez Chain, and the entrance the Lopez Pass. Several large islands are found inside. Vancouver's boats evidently were in this bay, as his chart gives a good general idea of it. The anchorage of Shoal bight continues some distance northward of this opening, and abreast of some moderately high white bluffs. N.NE. three-quarters of a mile from Bird Rocks lies *Belle Rock*,† directly in mid-channel, making a very dangerous position. It shows 4 feet above the very lowest tides, and is covered by a patch of kelp, which is, however, generally run under by the strength of the currents. The rip upon it can sometimes be seen when the water is smooth, but with light winds and high tides its existence would not be suspected. On all sides of it the water is very deep. The extent of rock above water is about 20 feet square. We discovered this danger in 1854, and while placing a signal upon it noticed that the tide rose nearly $1\frac{1}{2}$ foot while the current was yet running ebb at the rate of 3 miles an hour. Between it and the Bird Rocks there is a submarine ridge with plenty of water, but marked by strong eddies. The steamship Republic lately ran upon this rock, and more recently the pilot-boat Potter.

After passing Deception island on the east the face of Fidalgo island is high, precipitous,

* Named by the United States Exploring Expedition.

† Named by the United States Coast Survey, 1854.

and bare for two or three miles in a northwest direction. This is called Sares Head.* It then sweeps to the north, changing to the westward until abreast of and two miles from Belle Rock. In this deep bay, and lying well off shore, are, first, *Williamson's Rocks,** a cluster of rocky islets about 40 feet high, with deep water close around them. From Deception island they bear NW. $\frac{3}{4}$ W. 3 miles distant, and from Southeast island off Watmough Head, NE. 5 miles. Half a mile northward of them is *Allan island,** which is about three-quarters of a mile in extent, and about 200 feet high, with its southern face partly bare. A quarter of a mile off its SW. face lies the *Denis Rock.** This is never bare, but its position is marked by a patch of kelp.

North of Allan island, and separated from it by a channel a quarter of a mile wide, is *Burrow's island,** $1\frac{1}{2}$ mile long SE. and NW. by half a mile in width. The island is several hundred feet high and has a remarkably flat top, is wooded, and may be seen from the Strait of Fuca. At the eastern end of the passage, between the last two islands, is a small one called *Young island.** Through all the channels formed by these islands a good depth of water exists, and no dangers have been discovered.

The breadth of Rosario strait at Belle Rock is $3\frac{1}{2}$ miles; but it is soon contracted by *James' island** on the western side, and opens into a channel N.NE. called the *Bellingham channel,*† which is about 2 miles wide at its entrance. A small channel runs from it more to the eastward along the north shore of Fidalgo island, and leads into Padilla bay. Upon Fidalgo rises Mount Erie* to a height of 1,250 feet, covered with woods, and presenting a flat appearance from certain directions. James' island consists of two heads a mile apart and 250 feet high, but connected by a narrow ridge. The southern head is the higher, and not very heavily timbered. Close to the west of the ridge lies another head, connected with Decatur island by a low sand beach.

Just beyond James' island is an opening on the west between Decatur island and Blakely island,* and on the east half, a mile up the strait, appears the SW. point of Cypress island,* off which lie rocks and foul bottom for half a mile on a line to Burrow's island. Around this locality extends a large body of kelp. The southern face of Cypress island consists of alternate perpendicular white cliffs, and sloping ground covered with fern or trees. On its western side, and $1\frac{1}{4}$ mile from the southwest point is found a snug little harbor called *Strawberry bay,*‡ which is formed by the retreating of the shore-line, and an outlying rocky islet called Strawberry or Hautboy island.* In this bay excellent anchorage is found in from 6 to 10 fathoms, muddy bottom. Good fresh water is plenty here. A high white cliff is seen to the south of the harbor, from the shores of which rise rapidly the Lake mountains,§ to an elevation of 1,525 feet, and among whose peaks we found two large sheets of fresh water. These peaks are very noticeable from the Strait of Fuca, and being connected by comparatively low ridges with other hills on the island they present a saddle-like appearance from the southward and westward.

Abreast of Strawberry island the channel contracts to a width of $1\frac{1}{2}$ mile, where the bold rocky face of Blakely island rises to a height of between 900 and 1,000 feet. Nearly half a mile SE. from its east face lies a very small low rock called *Black Rock,* and half way between it and the south end of the island is a *white rock,* a quarter of a mile from the shore. In this narrow part of the strait the depth of water is about 60 fathoms, and the current goes through

* Named by the United States Exploring Expedition, 1841.
† The Indian name is Tut-segh.
‡ Named by Vancouver, 1792. The Indian name is Tutl-ke-teh-nus.
§ Named by the United States Coast Survey, 1854.

with a roar like the sound of a gale of wind through a forest. When at anchor in 10 fathoms, under the low point $1\frac{1}{2}$ mile north of Strawberry island, we found the current 4 miles per hour, and swirling so much that the vessel had to be steered to prevent her breaking her sheer. Thence on the strait widens upward, and at the north end of Blakely, 2 miles above Strawberry island, two channels lead to the westward around Obstruction island,* which lies between Blakely and Orcas islands. Both are narrow, and off the entrance to the south lie some sunken rocks, and others above water. Blakely island and Orcas island are three-quarters of a mile apart.

When in the narrowest part of Rosario strait, a very marked perpendicular rocky peak is seen to the north over the low point of Cypress, and soon shows rising abruptly from the water's edge to a height of 750 feet. It is called Bald Peak.† Abreast of it the channel takes the first turn, changing its course to N. by E. $\frac{3}{4}$ E., for $3\frac{3}{4}$ miles. Half a mile off the north end of Cypress island is a small islet covered with trees and called Rock island.‡ NW. of it are some sunken rocks, but their exact position is not accurately known. The comparatively low island half a mile N.NE. of Cypress is Sinclair island,* the highest part of which is towards the eastern end. Off the northwest face of Sinclair island, and stretching half a mile, is Boulder Reef,† visible at extreme low tides. It is covered with kelp, which is, however, generally kept under the surface of the water by strong currents. A huge erratic granite boulder is seen at ordinary tides inside of the outer point of the reef, and bears from it S. 70° E., distant 500 yards. From the western point of the island the reef bears exactly north, distant three-quarters of a mile. The revenue cutter Jefferson Davis and the steamship Panama have been upon it since we discovered it in 1854. On the north side of the island is anchorage in 10 to 15 fathoms half a mile off shore.

Three miles from Sinclair island lies Orcas, on the northwest side of the strait. It is a large island, with a mountain 1,120 feet high near its southern end. The point stretching furthest and coming down to the water is *Point Lawrence*,* and the low, treeless islets and reef passed $1\frac{1}{2}$ mile before reaching this point, and lying over half a mile off shore, are the Peapods.* Deep water is found close to them. When upon this same mid-channel course, the island ahead is *Lummi island*.§ Its southern half is very much higher than the northern, and attains an elevation of 1,560 feet. The rock nearly 100 feet high off the highest part of the ridge, and a third of a mile from shore, is the *Lummi Rock*,‡ and a capital boat harbor is found on its northwest side. A mile off its south end are the *Viti Rocks*,* about 25 feet high, with plenty of water around them.

Abreast of Point Lawrence the channel is over 3 miles wide, and it there changes to NW. $\frac{1}{2}$ W. for $6\frac{1}{2}$ miles to a line joining the *Matia group* with the north end of Lummi island. From Point Lawrence, along the north face of Orcas, the shore is rocky and precipitous, and rises by two or three plateaux to Mount Constitution,* which is less than a mile in-shore, and 2,397 feet high. The course out passes on the west some small rocky islets called *The Sisters*,* marked by one or two stunted fir trees; then *Clark's island** and *Barnes' island*,* close under its western side, leaving a channel a mile wide between it and the north shore of Orcas, with very deep

*Named by the United States Exploring Expedition, 1841.

†Named by the Coast Survey in 1854. The Indian name for Bald Peak is Sheh-ung-tlh, signifying the home of the Thunder bird.

‡Named by the Coast Survey in 1854.

§Named by the United States Coast Survey, 1853.

water and no anchorage. Abreast of Clark's island, or Lummi island, is a contracted anchorage and shelter from northerly winds under a low point called Village Point.* The anchorage is in 10 to 15 fathoms, but there is no fresh water, and the large Indian village is now deserted. After passing this point, anchorage may be obtained half a mile from shore in from 8 to 15 fathoms. Close to Clark's and Barnes' islands the depth is 50 and 60 fathoms, and a very strong current runs near them. The channel between Village Point and these islands is two miles wide.

W.SW. of the north end of Lummi island, and 4 miles distant, are three islands very close together, called the *Matia group*. A mile and a half to the westward of them lies the *Sucia group*, consisting of one large and six small islands, with a reef off the north side of the group, and a beautiful harbor a mile long and half a mile wide, opening to the east, and carrying from 10 to 15 fathoms sticky mud bottom.† To the westward of this group lies *Patos island*, and a much smaller one close to its SW. point. The eastern point of Patos island bears W. ¾ S., 9 miles from the north end of Lummi. Two or three miles N.NE. of Lummi island opens a shoal bay, backed by low marshy ground which is covered with trees and swamp undergrowth. Into it empties one or two mouths of the Lummi river. The main entrance of that stream is at the north part of the bay, and can be reached with boats only at high tide. The NW. boundary of the bay is a low grassy point with a few bushes upon it, called *Sandy Point*.‡ From the north point of Lummi island it bears N. by W. ½ W., distant 2¼ miles. Between these two points anchorage is had in from 4 to 6 fathoms, but the south end of Sandy Point should not be approached within less than half a mile. Down the east side of Lummi island, which is about a mile in breadth, runs Hale's Passage,‡ three quarters of a mile wide. It leads from Bellingham bay. In this passage 1½ mile, and bearing E. by S. ½ S. from the north end of Lummi island, is a low sandy point, upon which was established in 1853 a secondary astronomical station of the United States Coast Survey. Its geographical position is—

	°	′	″	
Latitude	48	44	01.7	north.
Longitude	122	40	36.9	west.
	h.	m.	s.	
Or, in time	8	10	42.5.	

This would place the north end of Lummi island in—

	°	′	″	
Latitude	48	44	53.2	north.
Longitude	122	42	11.9	west.

The following geographical positions will serve to check the courses and distances we have given:

Matia island, east, latitude 48° 44′ 36″.8 north.
" " longitude 122° 48′ 28″.6 west.
South end of Strawberry island, latitude 48° 33′ 34″.3 north.
" " " longitude 122° 43′ 26″.7 west.
SE. island, off Lopez island, latitude 48° 24′ 53″.3 north.
" " longitude 122° 48′ 33″.9 west.

Shoal.—From the north point of Lummi an extensive 5-fathom shoal bears W. by N. ¼ N.

* Named by the United States Coast Survey, 1854.
† Partially examined by a Coast Survey party in 1858.
‡ Named by the United States Exploring Expedition, 1841.

$5\frac{1}{3}$ miles, and NW. by N. $\frac{1}{2}$ N. $3\frac{1}{2}$ miles from the eastern of the Matia group. It lies upon the last direct course out of the strait, but has not been completely sounded out. Within the 15-fathom curve it is at least two miles square, and may be used when a vessel loses the wind and has a strong adverse current; but the swirls and eddies upon and around it will be very apt to foul any anchor.

From about its middle part we have the following bearings of prominent objects:

Eastern of Matia group, SE. by S. $\frac{1}{2}$ S. $3\frac{1}{2}$ miles.

North point of Lummi island, E. by S. $\frac{1}{4}$ S. $5\frac{1}{3}$ miles.

NW. point of Sucia group, with the wooded island of the Skipjacks just open, SW. $\frac{1}{4}$ S. 4 miles.

This position will bring the west side of Clark's island just on with Point Lawrence.

The shoal was discovered by the United States Coast Survey in 1853.

In 1857 we attempted to reach this bank four or five times, from an anchorage off Hale's Passage, with light airs, but the currents invariably swept us away from it. Recently it has been anchored upon by the United States Coast Surveying brig.

Once in the Gulf of Georgia, through either channel, the three-mile face and timber-covered bluffs of Point Roberts* (showing almost as an island) is seen to the northwest. On the west the mountains of Vancouver and its bordering islands rise up precipitously, and on the eastern or main shore a series of wooded cliffs 200 feet high. Far to the eastward the Cascade Range is seen rising above intermediate ridges, with the snow-covered summit of Mount Baker,† which bears its head 10,500 feet above the level of the sea. To the W.NW. stretch the waters of the Gulf of Georgia, 9 miles wide, abreast of Point Roberts, where it is narrowest, but spreading out to 20 miles and having a length of 120. A short distance above the 49th parallel it receives Fraser's river, (the third great stream of the northwest coast,) the branches of which spread towards the Cascade Range of mountains.

GULF OF GEORGIA.†

If bound up the Gulf, hold well to the eastern shore to avoid the rushing currents, and to take the chances of an anchorage if the wind fails.

From Sandy Point to *Point Whitehorn** the general trend of the shore is NW. $\frac{1}{2}$ W., and the distance 7 miles. The shore is a steep bluff, about 150 feet high, and covered with wood. At Whitehorn the face of the point is worn away by the action of the sea, and shows bright, with rocks at its base.

BIRCH BAY.

The southern point of this fine bay is Point Whitehorn, and the northwest shore is formed by a long rounding high bluff, bearing about NW. from Whitehorn, and distant 3 miles. The bay runs N.NE. $2\frac{1}{2}$ miles, with a width of $1\frac{1}{2}$. The bottom is very uniform, with capital holding ground of soft mud in from 4 to 10 fathoms. Inside the immediate shores are low, and edged with marshy patches, thick undergrowth, and heavy wood. No directions are necessary for entering, as there is a depth of 15 to 20 fathoms a mile outside, and 10 fathoms water on the line of the entrance. During the heaviest southeast weather no swell is felt here in a properly selected anchorage. We searched for fresh water, but found none in the space of more than a mile along its southeastern side.

* Named by the United States Exploring Expedition, 1841.

† Named by Vancouver, 1792.

The approximate geographical position of Point Whitehorn is—

	°	′	
Latitude	48	53½	north.
Longitude	122	47½	west.

It received its present name in 1792 from Vancouver, who placed it in latitude 48° 53½′.—(See Vol. 1, pp. 315, 316.)

This is the furthest point northward to which our personal examinations have extended.

Passing the bluff NW. of Birch bay the shore trends about N.NE. for nearly 3 miles, and terminates in a long, low, sandy point, behind which lies a small land-locked harbor, having a depth of 10 fathoms inside. The approaches to it, however, do not show over 5 fathoms at a distance of a mile from the shore, and the same depth is found on gradually nearing the end of the low point. The southeast shore of the harbor is flat and marshy, and is not separated by much more than a mile from Birch bay.

In this harbor the United States and British steamers attached to the Northwestern Boundary Survey were accustomed to anchor (1857.) The American commissioner encamped on the bluff about a mile north of the boundary, the site having been selected on account of fresh water, but it has an extensive flat in front.

Stretching to the northwest is a large shallow marshy bay, fringed with trees and bushes. From its northern shore low land extends as far back as Fraser's river. The western boundary of the bay is formed by the eastern shore of Point Roberts.

POINT ROBERTS.

The southwestern extremity of this point is low, and bears west 12 or 13 miles from Point Whitehorn. Its approximate position is consequently—

	°	′	
Latitude	48	58	north;
Longitude	123	05	west,

or about two miles below the boundary of the United States.

On the outer or Gulf of Georgia side of Point Roberts the shore runs about NW. 9 or 10 miles to the southern and principal mouth of Fraser's river. The south front runs E.NE. 3 miles, and presents for nearly the entire distance a bold bluff about 250 feet high, and covered with wood. Half a mile off this shore anchorage may be had in from 10 to 15 fathoms, but in southerly weather it must be avoided. The eastern shore of the point runs nearly parallel with the western for 4 or 5 miles.

A coast survey hydrographic reconnaissance was made of this vicinity in 1857.

BRITISH COLUMBIA.

FRASER'S RIVER.

After leaving the shores of the Gulf the channel passes through an extensive flat, partially bare at low water, and stretching 5 or 6 miles off shore. The channel is very crooked, and no buoys mark its course. Practicable ranges and marks, moreover, are too distant to be of use, and hence the lead must be relied upon entirely. Two or three American river steamers now ply upon the river. Its current is said to have a velocity of from 5 to 8 miles per hour.

The river was discovered by the Spaniards in 1790; and Galiano informed Vancouver (1792) that it was called the Rio Blancho, in honor of the then prime minister of Spain, but that it had been searched for in vain. It receives its present name from its explorer.

The shoal off it Vancouver called *Sturgeon Bank*.

NANAIMO BAY.

This bay lies on Vancouver island beyond the 49th parallel, and we refer to it because supplies of coal (lignite) are there obtained by many steamers.

The outer entrance to the harbor is in latitude 49° 12′ north, longitude 123° 51′ west, and bears W. ¼ N. 33 miles from Point Roberts. From the entrance the mid-channel course runs S. ½ W. 5 miles, passing a small island on the northwest at the distance of a mile, and a large island, with islets off its north point, three-quarters of a mile on the east. This course gradually approaches Douglas island on the west, abreast of a wide channel to the east, and is rounded quite close. The mines will then lie about W.SW. a mile distant, with a small islet in front of them. The bottom is uneven; some sunken rocks occur, and the anchorage near the rivers is so contracted that vessels must moor. Pilots will be found here to take vessels in.

The price of the coal per ton is about six dollars, but it is light; occupies one-fifth more space than Welsh coal; burns rapidly with flame and much smoke; disengages a great deal of gas, and produces clinker in abundance. It is, however, superior to the coal of Bellingham bay.

The usual spelling of this name is Nanaimo, but that best representing the sound is Nah-ny′-moh.

Of the western shores of the Gulf of Georgia we can say but little. The currents rush past its precipitous shores with great velocity, and quite recently the coast surveying brig drifted, with 38 fathoms of chain at her bows, in a calm, for miles along and within 80 yards of the rocks before she brought up. In one or two instances preceding this the lead indicated bottom in 10 fathoms, the next cast showing 40 or 50 fathoms.

ARCHIPELAGO DE HARO.

THE TWO STRAITS.

The experience of three season's surveying in this immediate locality has not increased our relish for navigating these channels in sailing vessels. With plenty of wind no navigation could be better, but in a calm vessels will frequently be jammed close to rocks, with only a few fathoms inside of their positions, but 40 or 50 outside, and a swirling current that renders towing with boats utterly impossible. Frequently, too, boats have been nearly swamped by the tide rips that exist through them. Off East Point, as an instance, a five-oared whale boat entirely failed in trying to hold her own against the current, which we judged to be *rushing* (the only term applicable) at the rate of 7 miles per hour. Throughout the Canal de Haro the roar of the conflicting currents can be heard for miles, and the main current runs frequently 6 miles per hour. No anchorages exist in this channel except at Cordova bay, but it is free of known hidden dangers except *Unit Rock*, off Darcy island. It is 10 miles longer than the Rosario Strait, and makes a right angle in its course, but is a mile wider. Rosario Strait is less curved, has several anchorages and known dangerous rocks, and a current of about 1½ mile less per hour. For steamers either channel, or even some of the narrow intermediate channels may be used; but for a sailing vessel the Rosario Passage is preferable, although the total distance from the middle of the Strait of Juan de Fuca to the middle of the Gulf of Georgia is 5 miles longer. The winds are apt to fail in both channels, and during summer frequent calms prevail.

We never heard thunder in this Territory except in one instance, at Cypress island, in Rosario Strait.

BELLINGHAM BAY, (WASHINGTON TERRITORY.).

Before passing to a description of Admiralty Inlet we will notice this bay, as mines of coal (lignite) have been opened upon its shores.

After leaving Rosario Strait, the course upon entering the channel, two miles wide, opening south of Cypress island, is NE. for 2 miles. The width then decreases to a mile upon turning sharp around the SE. point of Cypress, and to the eastward are seen the bright bluffs of *Guemes island.* Between these two islands the channel runs about 3 miles on a N. by W. ½ W. course. Abreast of the north end of Guemes, which is a steep bluff, and on the west side of the channel, are several small, high, wooded islets, called the *Cone islands.** The moderately low, wooded island facing the channel is Sinclair; vessels pass between the southeast point of it and the north end of Guemes. The island a couple of miles to the NE. is *Vendovi;** pass north of it but south of the small islet, (off Eliza's island,) which is 2 miles NE. by N. from the NW. point of Vendovi, and the southern part of Bellingham bay opens to the southeast; its northern part opens to the N.NW.

If the current is flood and the wind light keep close around Guemes and Vendovi, so as not to be set past Sinclair island. The low, bare, rocky islets, 1½ mile NW. of Vendovi, are the Viti Rocks; and the point between them and Eliza's island is the southern extremity of Lummi island. From the islet last passed, a point on the eastern shore lies nearly north 5 or 6 miles distant. Run past this and follow the trend of the shore for 2 or 3 miles to the deepest part of that portion of the bay, when houses, &c., will denote the position of the mines and the villages of Sehome and Whatcom. Half a mile from the shore is capital anchorage in 4 fathoms, soft bottom, and the bay there is very smooth.

The general direction of Bellingham bay is SE. and NW.; its width 3 miles and length 14, extending from latitude 48° 33′ to latitude 48° 48′. The depth of water ranges from 3 to 20 fathoms, with good sticky bottom.

A hydrographic sketch of the bay was published in the Coast Survey Report for 1856.

We believe there are several companies mining here, but the amount of coal obtained is not great. Its quality is not good, the furnaces producing sometimes as much clinker and ashes in bulk, and half the amount in weight of the coal put in. Deleterious gas is freely disengaged, and the combustion also evolves clouds of black smoke. In the experiment which we witnessed, in 1853, the steamer's furnaces could not, in two attempts, be kept up so as to produce a sufficiency of steam.

A saw-mill is located upon the bay at one of the villages.

Bellingham bay was first surveyed by Whidbey, under Vancouver's orders, in 1792, and then received its present name. In some recent maps the northern portion is called Gaston bay, and for the southern part the original name is retained; but Vancouver's designation is that universally adopted on the western coast.

A military station is located at the upper part of the bay, opposite to the coal mines.

The amount of shore-line in the Archipelago de Haro, Bellingham bay, Possession sound, &c., is 627 miles.

*Named by the United States Exploring Expedition, 1841.

ADMIRALTY INLET.

General Features.—This inlet may be described as a vast canal, commencing at the southeast extremity of the Strait of Juan de Fuca and running in a general SE. by S. direction for 60 miles to the south end of Vashon's island. It has for that length an average width of $3\frac{1}{2}$ miles, and then branches into a multitude of arms, which cover an area of about 14 by 22 miles. Their general direction is SW. $\frac{3}{4}$ S., and they comprise what is called *Puget's Sound.*

At 16 miles from the entrance to the inlet an arm called *Hood's canal* opens upon the western side, and runs 60 miles S. by W., with an average width of $1\frac{1}{2}$ mile. Twenty-five miles from the entrance of the inlet another arm opens on the eastern side, runs north and northwest behind Whidbey island, forming Possession sound, ports Gardner and Susan, &c., and leads on to the Strait of Juan de Fuca through Deception Pass, at the north end of Whidbey island.

The shores are generally bluffs, ranging from 50 to 500 feet in height, with their sides kept bright by the gradual wearing action of the water, and their tops covered with trees and thick undergrowth to their very edges. There is so much sameness in the shores that it requires some acquaintance with the different points to recognize them by their trifling peculiarities. The depth of water in the channels is remarkably great, perhaps averaging 100 fathoms; and it is sometimes difficult to find anchorage sufficiently far from the shore to afford room for getting under way Many superior harbors are found in every direction, and small settlements are gradually springing up in favorable localities.

Admiralty inlet, Hood's canal, and Puget's Sound, have an aggregate shore line of not less than 803 miles, yet the number of dangers known to exist in them is remarkably few.

One of the inlets or arms of Puget's Sound reaches within two miles of the head of Hood's canal, and between them lies a large lake. The southern waters of this sound are also within 55 miles, in a direct line, of the Columbia river, at the mouth of the Cowlitz, 46 miles from Cape Disappointment, and within 20 miles of the upper waters of the Chehalis river, which runs into Gray's bay. At present the route travelled from the Columbia is by canoes, for less than 20 miles, up the Cowlitz to the settlement at "Cowlitz Landing," (or by horse over a somewhat bad path,) and then by horses or mules to Olympia, over a tolerably level country, and by a road moderately good in summer but bad in winter. The distance can be made in one day with a good horse. From where the road strikes the Chehalis the river is said to be navigable for large boats to Gray's harbor. We judged the stream to be about 100 yards wide. It had apparently plenty of water, and a slow current. The Cowlitz has a rapid current, and at a low stage of the water canoes are poled up its channel; during freshets they are dragged up, the crews clinging to the branches of the trees upon its banks. Two days of labor are then required for the trip, but in summer it is made in one.

The importance of these close relations of the waters of the Columbia river, Puget's Sound, Admiralty inlet, Gray's harbor, and Shoalwater bay, in view of the prosperity of the two Territories, must be manifest without entering into details of the feasibility of their connection by railroads and canals.

The inlet was discovered by Quimper, in 1790, and called the Canal de Caamano. It was first explored and made known, in 1792, by Vancouver, who applied the present name to it.

A reconnaissance sketch of Admiralty Inlet was published by the Coast Survey in 1854.

We shall not attempt to give in full and explicit detail all the peculiarities of this vast area of waters, but, following the mid-channel courses, will only note generally the objects as they come under the eye of the navigator.

The entrance to the inlet lies between Point Partridge, on Whidbey island, and Point Wilson, on the main, at the entrance to Port Townshend. The bearing of the latter point from the former is SE. by S. ½ S., 4½ miles; and the bluff head lying 2 or 3 miles to the east of this line, and destitute of trees, is Admiralty Head,* around which the ebb current, and an ebb eddy on the flood, sweeps with force.

The first course inside of the entrance of the inlet is E.SE. 6½ miles, passing Port Townshend on the south, Admiralty Head on the north, and changing the course abreast of Marrowstone Point on the W.SW.

Point Partridge is the western point of Whidbey island, and directly faces the Strait of Juan de Fuca. It is very steep and yellow, and flat on the summit, which is covered with spruce, fir, and cedar. The point is so rounding that it is not easily recognized on coming from the westward, but from the south and north it is well marked and prominent. Its face is composed of loose sand, which, being blown up the hill by the strong west winds, has formed a very peculiar ridge on the outer face of the top. This is so narrow that it can hardly be travelled, and in many places it is 35 feet above the ground inside, yet, being overgrown with bushes, the ridge is now permanent.

The highest part of the point is about 260 feet above low water.

The triangulation of the Coast Survey was on the southern part of the point, and its approximate geographical position is—

	°	′	″	
Latitude	48	12	59	north.
Longitude	122	45	07	west.

From Point Wilson it bears NW. by N. ½ N., 4¼ miles.

From Admiralty Head, NW. by W. ¾ W., 5¼ miles.

It received its present name from Vancouver in 1792.

PORT TOWNSHEND.

This harbor is favorably situated at the termination of the Strait of Juan de Fuca, at the outlet of the waters of Admiralty Inlet, Puget's Sound, &c., and in proximity to the great inland waters of British Columbia. The entrance lies between Point Wilson* and Marrowstone Point†, the latter bearing E.SE. 3⅝ miles from the former. Upon this line, and even outside of it, lies a bank extending two-thirds of the distance from Marrowstone, and having from 6 to 15 fathoms, with hard, sandy bottom. Inside of Point Wilson, which is composed of low, sandy hillocks, as heretofore described, lies another low point called Point Hudson‡, distant 1¾ mile, SE. by S. ½ S.

Starting from the entrance line, about 1½ mile from Marrowstone, the mid-channel course of the bay is S.SW., 3 miles, with an average width of 2; thence SE. ⅛ S. for 3½ miles, with an average width of 1¼. The depth of water throughout is very regular, and ranges from 8 to 15

* *Red Bluff* of the United States Exploring Expedition. It has now no marked color to suggest the appellation.

† Named by Vancouver in 1792. On one edition of the maps of the United States Exploring Expedition the latter point is called Point Carroll, and on another Point Ringgold.

‡ Named by the United States Exploring Expedition, 1841.

fathoms, with soft, muddy bottom inside of Point Hudson. Vessels coming from the strait steer for Point Hudson, as soon as it is opened by Point Wilson, passing the latter close, as 20 fathoms are found 100 or 200 yards off it. Upon approaching Point Hudson, and when within half a mile of it, gradually keep away about a quarter of a mile in from 5 to 10 fathoms, and, as it opens, run quite close, with the summer wind off shore, to save making a tack; keep along half a mile to the town situated under the Prairie Bluff, and anchor anywhere off the end of the wharf, in 10 to 12 fathoms, about a quarter of a mile from shore. In winter anchor further out, to clear Point Hudson in getting under way with a southeaster.

If coming down the inlet, bound into the bay, and the current is ebb, pass Marrowstone nearly three quarters of a mile before heading in for the town, and so avoid a very strong eddy which comes out of the bay along the bluff shore west of this point. If the wind is light and the current strong, pass the Point quite close; run along the outside of the rip, and try to get upon the bank as soon as practicable.

In summer vessels frequently drift about the entrance for days, without a breath of wind, and in very strong currents.

A preliminary chart of the locality appeared in the Coast Survey Report for 1854.

The *town* numbers a few houses, and in the vicinity are some good farms. The place is noted for the rough character of its "beach combers."

A military post has been established on the bluff, $2\frac{1}{2}$ miles S. by W. from the town, and on a site which commands one of the most beautiful views in these waters, having the bluff and varied shores of the bay on either hand; Admiralty Head, 6 miles distant, in the middle ground; several distant, wooded ridges, and in the background the snow-covered, double summit of Mount Baker, with the mouth of the crater distinctly visible between the peaks, and at times emitting vast volumes of smoke.

On the east side of the bay, abreast of the town, lies a long sand spit, nearly closing the north entrance to Kilisut harbor, which runs parallel to the inlet, and is separated by an island a mile wide and 6 miles long. At high tide this harbor communicates, by a crooked boat channel, with Oak Cove, at the south end.

At the head of Port Townshend is a narrow channel opening into a large flat, bounded by a low, sandy beach, separating it from Oak Cove. The Indians frequently use this as a portage.

The shores are generally bluffs, about 120 feet high, and covered with wood, except behind the town. Between the town and Fort Townshend are two low pieces of grass and sand beach, backed by marsh and ponds. The 5-fathom curve extends but a few hundred yards from any part of the shores. A small patch of kelp lies off the southern point of Prairie Bluff, and another off the north face of Marrowstone Bluff. No fresh water is to be had at the town, but vessels can obtain a small supply near the military post. Vegetables generally are plenty, and the prices moderate.

Between Port Discovery and Port Townshend lies a peninsula 3 miles wide, offering great advantages as a location for a town. No name has hitherto been applied to it, and we have ventured to designate it as the Quimper Peninsula.

The geographical position of the triangulation station of the Coast Survey, upon Point Wilson, is:

	° ′ ″
Latitude	48 08 42.7 north.
Longitude	122 44 49.4 west.
	h. m. s.
Or, in time	8 10 59.6.

The position of the triangulation station on the extremity of Point Hudson, computed from the secondary astronomical station near the town, is:

	° ′ ″
Latitude	48 07 06.7 north.
Longitude	122 44 25.6 west.
	h. m. s.
Or, in time	8 10 57.7.

Magnetic variation 21° 40′ east, in August, 1856, with a yearly increase of 1′.4.

From the above it will be seen that Point Hudson is about 1*m.* 25*s.* west of Telegraph hill, San Francisco.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is III*h.* XLIX*m.* The mean rise and fall of tides is 4.6 feet, of spring tides 5.5 feet, and of neap tides 4.0 feet. The mean duration of the flood is 6*h.* 34*m.*, and of the ebb 5*h.* 52*m.* The mean difference between the corrected establishments of the a. m. and p. m. tides of the same day is 2*h.* 22*m.* for high water and 0*h.* 35*m.* for low water. When the moon's declination is greatest these differences are 4*h.* 38*m.* and 0*h.* 27*m.*, respectively; and when the moon's declination is zero they are 0*h.* 40*m.* and 0*h.* 29*m.* The mean difference in height of these two tides is 1.1 foot for the high waters, and 4.6 feet for the low waters; when the moon's declination is the greatest they are 0.6 foot and 7.3 feet, and when the moon's declination is zero 1.4 foot and 1.4 foot. When the moon's declination is greatest, and north, the two high waters of the day follow the moon's upper transit, respectively, by about 6*h.* 8*m.* and 13*h.* 56*m.*, and when greatest, and south, by about 1*h.* 30*m.* and 18*h.* 34*m.*, the height of the two being about equal. When the moon's declination is zero, and passing from north to south, they follow the moon's transit by about 4*h.* 9*m.*, and 15*h.* 55*m.*, and the first rises about 1.4 foot higher than the second. When the moon's declination is zero, and passing from south to north, they follow the moon's transit by about 3*h.* 29*m.* and 16*h.* 35*m.*, and the second rises higher than the first by the same quantity. When the moon's declination is greatest, north or south, the two low waters follow the moon's transit by about 9*h.* 41*m.* and 22*h.* 7*m.*, but when north the second falls lower than the first by about 7.3 feet, and when south the first falls lower by that quantity. When the moon's declination is zero, the two low waters fall nearly equally. The greatest difference observed between the heights of the two low waters of a day was 8.6 feet, and the greatest difference between the highest high and lowest low water of a day was 10.1 feet.

Port Townshend was surveyed and first made known, in 1792, by Vancouver, who gave it the present name, by which it is always known.

It was examined and named by Quimper in 1790.

In 1855–'56, a law was passed appropriating a sum for building a light-house upon "Red Bluff," but the recommendations of sea-faring men have fixed generally upon Point Wilson as the most suitable location. Red Bluff or Admiralty Head has the advantage of being seen further up the inlet, but is shut out from Smith's Island light, while Point Wilson commands both it and Dungeness light. Around Point Wilson all the navigation and commerce of the inlet and sound turn; and from it vessels take their departure when going out in foggy or smoky weather. A vessel entering Port Townshend at night could easily know her position with the light on Point Wilson, and could enter it with certainty. Coming out of the inlet and bound into the bay she would have a good course to run by, when the light was opened by Marrowstone Point.

Marrowstone Point is a low sandy point stretching 300 yards eastward from the base of the bluff, and forming an indentation on its southern face, where anchorage may be had in 12 fathoms, with a current or eddy invariably running ebb. Small craft coming out of the inlet with a head wind can easily take advantage of this for 2 or 3 miles above the point.

It received its present name from Vancouver in 1792.

Admiralty Head, abreast of the entrance to Port Townshend, is a perpendicular cliff 80 feet high, falling on the eastern side to a low, pebbly shore, which runs 2 miles to the E.NE. and strikes the high cliffs on the eastern side of the inlet. Behind this beach is a large lagoon and off it is Admiralty bay, with hard, sandy bottom, in irregular ridges, and a depth of 15 to 25 fathoms of water. A strong current always makes out of the bay, as it is exposed to the full sweep of southeasters. The current is so strong that a vessel rides to it, and consequently lies in the trough of the sea.

The geographical position of the triangulation station of the Coast Survey on the extremity of Admiralty Head is:

	°	′	″	
Latitude	48	09	21.6	north.
Longitude	122	40	08.0	west.
	h.	*m.*	*s.*	
Or, in time	8	10	40.5.	

From Point Wilson it bears NE. by E., distant $3\frac{1}{4}$ miles.

From Marrowstone Point N. by W. $\frac{1}{4}$ W., distant $3\frac{1}{4}$ miles.

Starting from the last course abreast of Marrowstone Point the mid-channel course runs SE. by S. $\frac{1}{2}$ S. for 7 miles. The shores on either hand are bluffs of apparently uniform height, covered with trees. About 5 miles on this course is passed, on the eastern shore, a low point, with one or two clumps of trees and bushes, to which has been given the name *Bush Point.** On the western shore is a rounding bluff point one mile north of the point, which forms the northeast part of Oak Cove. Off this point is good anchorage in 12 to 15 fathoms. The peculiar geological formations, found in the vicinity, suggested the designation *Nodule Point,*† which it now bears. The high bold headland, several miles directly ahead, is Foulweather Bluff†; and that to the E. SE. destitute of trees, except one large clump, which marks it conspicuously from this direction, is *Double Bluff*‡. The deep indentation between it and Bush Point, with low land in the rear, is *Mutiny Bay,*‡ in the northern part of which exists a narrow bank of 11 fathoms, affording an excellent fishing ground. At the end of the course *Oak Cove,*§ opens to the westward, and stretches towards the waters of Port Townshend. It has bluff shores nearly all around it, those on the southwest face being limestone, but Basalt Point, at the south, derives

* By the Coast Survey parties in 1855.

† So named by Vancouver in 1792. The Indian name for Foulweather is Pitch-pōl.

‡ Named by the Coast Survey parties in 1855.

§ So called by Vancouver in 1792.

its name from its geological structure. The depth of water is 5 to 15 fathoms, except N.NW. of Basalt Point, where it reaches 25 and 30 fathoms. The length of the bay is 3 miles and its average width about 1½ mile. In beating out of the inlet, with a favorable current, vessels must not attempt to work to this bay for the sake of a long tack.

Vancouver called it Oak Cove, his people having reported that oak trees stood upon its shores. We have traversed the greater part of the shores but found none.

The *opening* west of Foulweather Bluff is *Hood's Canal.* Vessels bound into it keep close to the western shore of the bluff, and pass two low points lying near together. The water off them is deep. Off the north face of Foulweather, for nearly a mile, less than 15 fathoms may be found. Kelp exists under the face of the bluff, and vessels may pass round it in 6 and 7 fathoms. The bottom along the edge of the kelp is rocky. On the west side of the entrance to Hood's Canal is Port Ludlow, which will be described hereafter.

The next and third course is E.SE. for 10 miles, passing on the eastward Double Bluff, which stretches northeast for a mile, and rises 300 or 400 feet in height, having its top covered with wood. The bluff running also to the northward forms *Useless bay.** This has deep water over the greater portion of it, with a large shallow bay called *Deer Lagoon*† at its head. The high bluff forming the southern point of Useless bay is *Scatchet Head.*‡ A similar bluff lies 2 miles E. by S. of it. These form the southern extremity of Whidbey island, in latitude 47° 54′ N., and are the turning points into Possession Sound.

The two heads are about 300 feet high, covered with wood, and separated by a depression, which is in part overflowed at high tide, and then presents the appearance of a small bay. From the eastern head round the western, and a mile toward Useless bay, the low water line makes out half a mile, the shore being bare where some recent maps have deep water. For nearly a mile south of both heads a depth of 8 and 10 fathoms and smooth sandy bottom can be found. We found, when anchored for several days off the eastern head, a strong under current running into Possession Sound, and an outer current setting to the westward, at all tides. Vancouver makes mention of the shoal, and states that in beating into the inlet he stood on the bank until he got 5 fathoms, but want of time precluded his examining it.

On the western side of the last mid-channel course we pass *Foulweather Bluff,* which is perpendicular on its N.NW. face, and about 225 feet high, with heavy firs upon its summit. It slopes towards the east to a bluff 40 feet high, but is steep on the side next to Hood's Canal. The low point 4 miles east of it is *Point No Point,*§ making well out, and destitute of trees or bushes. Between it and Foulweather is a deep bight, and the distance across to Hood's Canal is only a quarter of a mile in one part, marked by the track of a recent tornado that has twisted off and uprooted firs of 3 and 4 feet diameter. On the south side of Point No Point is good anchorage in 10 fathoms, and thence onward the western shore runs nearly straight SE. by S. for 10 miles.

At the end of the last course, which carried us 3 miles beyond Point No Point, the inlet expands to a width of 7 miles. A course E.NE. for 3½ miles carries us to the entrance of Possession Sound, the first 6 miles of which run N. ½ W., with a width of 2 miles and bluff shores. It then turns to the northwestward to Port Gardner. The water is deep in the

* Named by the United States Exploring Expedition, 1841.

† Named by the Coast Survey parties, 1856.

‡ Named by United States Exploring Expedition, 1841. The proper spelling is Skadg'-it, and the Indian name of the point, Skoolhks.

§ Named by United States Exploring Expedition, 1841. The Indian name for the point is Hahd-skus.

entrance, and affords no anchorage. The low point on the eastern shore, 4 miles after entering, is *Point Elliott,** and the bay opening to the northeast receives the Sinahomis or Scaget river.

The next, or fourth, mid-channel course up the inlet is S.SE. for 21 miles to Allen's Bank, which lies a mile off the north end of Vashon's island. Five miles on this course, or 7 from Point No Point, brings us to an excellent little harbor on the western side of the inlet, called *Apple Tree Cove,** having a low point on the north side, with a soft mud flat extending several hundred yards up the inlet. From 5 to 12 fathoms water and sticky bottom are found off it and in the cove. There is no fresh water in the vicinity, but very good timber may be procured suitable for boat spars and booms. On the eastern shore of the inlet, abreast of this cove, are two low points, a mile apart, making out from the bluff. The indentation between them forms a good though small anchorage, and the chances are good for fresh water at high tide. The southern point is named *Point Wells**, the northern *Point Edmund.** The inlet is here only 3 miles wide, and continues so to *Point Jefferson*, 2 miles southward of Apple Tree cove. This is a moderately low straight bluff, with the ground rising behind it. Stretching broad off its eastern face for three-quarters of a mile we discovered, in 1856, a 9-fathom shoal, which affords capital anchorage for vessels when drifting with light airs and adverse currents.

PORT MADISON.

Point Jefferson is the northern side of the entrance to this port, which runs 3 miles W.SW., with an average width of 2 miles and a large depth of water, except under Point Jefferson, where anchorage may be had in 10 and 15 fathoms, hard sandy bottom, with patches of kelp inshore.

The southeast point of the entrance is low and sandy, making out from high wooded ground. One mile west of it is the narrow entrance to a natural canal, upon which, in full view, are situated the Port Madison saw-mills. At the SW. part of the bay is the very narrow entrance to *Port Orchard*. The channel is somewhat crooked, but it has 3 and 4 fathoms water in it. On the western side of this entrance are some white patches of beach, formed by clam shells. In 1857 an Indian village was situated here, and an Indian sub-agency. Both sides of the entrance are bluffs. Vessels not well acquainted with the channel must enter under easy sail, and keep a lead going on each side of the vessel to ascertain where the deepest water lies. After getting through give the point, one mile off on the western side, a berth of nearly half a mile, to avoid a shoal which makes out east from it. Thence it is plain sailing in 15 to 25 fathoms of water. After passing the first point an arm opens to the NW., and many vessels load there with spars. Ten miles up the southern channel is, or was, a saw-mill. In coming out of this port vessels should not trust the southern entrance, but leave as they entered.

Port Orchard was examined and named by Vancouver in 1792.

Bainbridge island lies between Port Orchard, Port Madison, and Admiralty Inlet. It is 8 or 9 miles long by 2½ in breadth, and its general direction is SE. by S. A few loggers huts stand on the western side and the Madison saw-mill at the north end. On the SE. part it is indented by two small harbors. It was named by the United States Exploring Expedition in 1841.

DUWAMISH BAY.

Abreast of Port Madison the eastern shore of the inlet retreats and there receives several small streams of water, but it gradually makes out into a very long, low sand point, called

* So called by the United States Exploring Expedition, 1841.

West Point,* which forms the extreme northwest part of the entrance to Duwamish bay. The bay runs E. by S. 6½ miles and has a width of 2 miles. To the south point, called *Battery Point*,† which is low and bare, with a curiously shaped mound rising sharply behind it, the course is about SE. by S. and distance 4½ miles. Under West Point there is anchorage in 10 to 15 fathoms after getting towards the bluff; but on the north side of the point the water is very deep. Through the centre of the bay the depth ranges from 88 to 40 fathoms. On the north side of Battery Point a vessel anchoring in 20 fathoms cannot have a greater scope of chain than 35 fathoms without being too close to the shore. When we anchored there in 13 fathoms and veered to 25 fathoms of chain the vessel's stern was in 2½ fathoms. The beach is smooth and very regular, being composed of sand and gravel. On this side of Battery Point is the deserted town of Alki, (the Indian phrase for "by and by.") The town has had several names, but there is nothing about it to command trade.

The bluff head within the bay, 2 miles NN.E. off Battery Point, is Duwamish Head. It is steep, about 150 feet high, covered with timber, and the beach at low water stretches out over a quarter of a mile N.NW. from it. The head of the bay receives the Duwamish river, and for one or two miles is an extensive flat, bare at low water.

The town of Seattle is on a small point at the NE. part of the bay, a little over 5 miles inside of West Point. It consists of a few houses and stores, a church, and a small saw-mill. It has but little trade.

The usual anchorage is directly off the wharf in 10 to 15 fathoms water, with the large white house on the extreme point bearing about E. or E. by S., and at a distance from the beach of about 500 yards. This position will enable a vessel to work out well by making the first tack to the southward towards the flat. If it is high water this flat cannot be distinguished, and the lead must be kept going. When a depth of 15 fathoms is struck go about, for it shoals to 3 fathoms very suddenly, and keeping on would soon bring up on the flat. If the current is ebb vessels bound out should stand well into the inlet; and if bound up work close under and around Duwamish Head to Battery Point. If the current is flood vessels bound out should work under the north shore, and close to West Point; if bound up work under the north shore about 3½ miles to Magnolia Bluff, beyond a low marshy indentation in the shore, or until they can fetch well clear of Battery Point.

There is said to be some good agricultural prairie land on the Duwamish river. Some distance up it is connected with *Lake Washington*, which is reported to be 25 miles long and several miles broad, with islands in it. It is but a few miles in a direct line east of Seattle. Another small lake exists about a mile back from the beach, a mile west of Seattle. This is reached by a trail.

The town of Seattle was attacked by a small body of Indians in 1855, but the assault was repelled by the United States steamer Massachusetts.

The bay was called Elliott's Bay by the United States Exploring Expedition in 1841, but the present name is that by which it is invariably known and was adopted from the name of the tribe of Indians inhabiting its shores. The name is derived from that of the Chief Se-at-tl.

The Coast Survey report for 1854 was accompanied by a reconnaissance sketch of Duwamish bay and Seattle harbor.

* Named by the United States Exploring Expedition, 1841.
† Named by the Coast Survey parties, 1856.

RESTORATION POINT.

From the SE. point of Port Madison to this point the shore is bluff and somewhat irregular, and is indented first by *Eagle harbor*,* having a long pebbly spit making out 300 or 400 yards SE. from its north point; and next, at Point Restoration, by *Blakely harbor*,* having off its entrance a large rock, 15 feet high, with deep water all round it. The rock bears nearly N.NW. three-quarters of a mile from the point, and the bottom between is irregular, the depth ranging from 20 to 40 fathoms. Blakely harbor is only a quarter of a mile wide and three-quarters long, with 18 fathoms sticky bottom at its mouth, and shoaling gradually inside, but most on the south side. A hydrographic sketch of the harbor will be found in the Coast Survey Report for 1856.

Eagle harbor is larger and more commodious than Blakely. The shoal off its north point is not, so far as we know, laid down on any chart.

Restoration Point is in some respects very peculiar, no other in these waters, except Battery Point, presenting the same formation. For 300 yards it is flat, about 10 feet about high water, and has a foot depth of soil covered with grass over a limestone rock, upheaved nearly on edge, the direction of the strata pointing toward Battery or a little south of it. Inshore it rises up sharply about 100 feet, its sides covered with grass and the summit with fir trees. Around the whole SE. face of the point these peculiarities exist. On the upper levels of the high land adjacent our party found small lakes of water.

From the extremity of the point a ledge, bare at low tides, makes out 300 yards, but the depth is 6 fathoms 100 yards off its extremity, and 16 fathoms at a quarter of a mile. On the tail of this ledge the United States sloop-of-war Decatur struck in 1855. S.SE. of the point anchorage may be had in 15 fathoms, sticky bottom, a quarter of a mile distant; or, as a rule for finding anchorage, bring the rock north of it to range just over and inside of the point. Kelp exists along the southern face.

The geographical position of the triangulation station of the Coast Survey upon this point is:

	°	′	″
Latitude	47	35	05.8 north.
Longitude	122	28	15.2 west.
	h.	*m.*	*s.*
Or, in time	8	09	53.0.

From this point Battery Point bears E. by N. ½ N., distant 2½ miles.

Tides.—The approximate corrected establishment is IV*h.* IV*m.*, and the approximate mean rise and fall of tides 7.4 feet.

Vancouver anchored under this point in 1792; found large numbers of Indians located near, and first called it Village Point, but changed it to its present name in commemoration of the day on which he anchored. From this place his boats explored all the waters adjacent.

South of Restoration the inlet opens to the westward for a couple of miles into a bay, in which is situated an island about three-quarters of a mile in extent, called *Blake island.** From the northwest part of the bay leads a narrow crooked pass 3 miles long to the southern part of Port Orchard, which spreads out into several arms. The pass is obstructed by rocks and is difficult of navigation. The winds are variable, light and uncertain at its narrowest part, where it makes a sharp turn, and is only a couple of hundred yards wide with a rushing swirling

* Named by the United States Exploring Expedition, 1841.

current. The channel generally used, although narrower than the one just mentioned, is that leading into Port Madison.

Our last course brought us to *Allen's Bank** off the north end of Vashon's island, with Blake island to the westward, and three-quarters of a mile distant. This bank is nearly a mile in extent, and has as little as 10 fathoms upon it, with a variable bottom, in some places mud, and in others hard sand. At our anchorage upon it in 11 fathoms the south end of Blake island bore N. 81° W., and the NW. point of Vashon's island S. 5° E. Between the anchorage and Blake island the water regularly deepens to about 18 fathoms in soft mud. This anchorage has already proved of service to vessels losing the wind and having adverse currents. The eastern point of Blake island is low and pebbly, and called by the natives Tatugh. Under it is anchorage in 17 and 18 fathoms, soft mud. The NW. point of Vashon's island is Dolphin Point, the northeast point Point Vashon, the point abreast of it is Point Southworth, and the mile wide channel, commencing between the last two points, is *Colvos Passage*, † running west of Vashon's island.

The extent of shore-line from the entrance to the north end of Vashon's island is 241 miles.

The main body of the inlet runs about SE. for 8 miles, then S.SW. 8 miles further, with an average width of two miles. In this stretch the currents are moderately strong; the chances for anchoring few; and it is sometimes calm while a nice breeze is blowing through Colvos Passage.

Brace Point ‡ lies on the east side of the inlet, NE. from Dolphin Point. The round-topped point having two or three lone fir trees upon it, and situated on the same side of the inlet, 4 miles above Brace Point, is called *Point Pully.* † The water is very deep close to it on either side.

The geographical position of the triangulation station of the Coast Survey on the summit of the mound is:

	°	′	″
Latitude	47	27	07.3 north.
Longitude	122	22	21.5 west.
	h.	*m.*	*s.*
Or, in time	8	09	29.4.

There is a small cove north of Brace Point, and between it and another low point called *Fauntleroy Cove*, § having good anchorage in 10 and 12 fathoms, and fresh water is easily obtained in the vicinity. Between Brace Point and Point Pully two or three small streams of water empty, and another from the valley a mile east of the high bluff at Pully. Off this valley a flat makes out with deep water at its edge.

Under Dolphin Point there is very deep water; but off the north end of the island, near this point, we found anchorage in 14 fathoms, hard bottom.

Colvos Passage is the usual, we may say the invariably used ship channel towards Puget's Sound. It is about a mile wide, with high bluff shores, varied by numerous small low sand points making out from the face of the bluff, and having deep water off them. The passage is 11 miles long to the south end of Vashon's island, which is called Dalco Point, † and it runs with a nearly straight course S. by E. A mile and a half inside of Point Vashon there is a small curve in the shore-line called *Fern Cove*, § with excellent anchorage in 5 and 10 fathoms.

* Discovered and named by the Coast Survey in 1857. In some recent maps 25 to 30 fathoms are marked on the site of this shoal.

† Named by the United States Exploring Expedition, 1841.

‡ Named by the Coast Survey in 1856.

§ Named by the United States Coast Survey, 1857.

Abreast of Dalco Point there is a small boat harbor, with a narrow and shoal entrance, called *Gig Harbor*. * Looking out of the passage to the north, Mount Baker shows distinctly in clear weather.

COMMENCEMENT BAY.

When abreast of Dalco Point this bay, at the termination of Admiralty Inlet, opens to the E.SE., and over its low background shows the high snow-covered peak of Mount Rainier. The general direction of the bay is E. by S. ½ S., with a length of 3 or 4 miles, a width of 2 miles, and a great depth of water up to the line of the extensive flat at its head, which is backed by marsh. There are no settlements upon it, but in 1857 we found some deserted fishing stations.

It was named, in 1792, by Vancouver, who thought this the entrance to some large arm of the inlet, on account of the low country beyond.

e believe the Indian name for this bay is Puyallup.

Vashon's Island, lying between the southern extremity of the inlet and Colvos Passage, is 11½ miles long, with an average width of 2½ miles. Half way down on its eastern side lies a curiously shaped peninsula, formed by a narrow, low, sandy neck of land which makes out into the inlet, and then runs towards the south point of the island. The space between this peninsula and the island is an excellent harbor 4 or 5 miles long, and three-quarters of a mile wide, with 5 to 10 fathoms water in it. The southeast face of the peninsula is high and steep, and bordered by water from 40 to 50 fathoms deep.

The island is high, with steep shores covered with wood and undergrowth. Its surface is marshy in many parts that are quite elevated. The present name was given by Vancouver in 1792. The harbor formed by it and the peninsula was called *Quartermaster's harbor* by the United States Exploring Expedition.

POINT DEFIANCE AND THE NARROWS.

The high, sharp yellow bluff facing the south entrance to Colvos passage is called Point Defiance, and between it and the western shore pass all the waters of Puget's Sound. This passage is called the Narrows. Its average width is three-quarters of a mile, and very uniform; the shores high, bold, and in some places rocky. For 2 miles to the SE. its course is a regular curve. The next turn is to the southward, and at a distance of 2 miles in that direction the waters of the sound open ahead, with a narrow pass between the main and Fox island to the west, and a small indentation, backed by low ground, and formed on the south by a small peninsula, on the east. In this curve is anchorage in 15 fathoms, with swirling eddies. On the south face of this peninsula, and outside of the kelp, anchorage may also be had.

PUGET'S SOUND.

This collection of inlets commences after passing "The Narrows," and covers an area of 14 miles by 22, with a general direction SW. ¾ S. The aggregate shore-line of this sound and the adjacent part of Admiralty Inlet, with Colvos Passage, to the north end of Vashon's island, is not less than 370 miles. Upon its shores are situated the settlements of Steilacoom, Nisqually, Olympia, and Newmarket.

It received its present name in 1792 from Vancouver, in compliment to Lieutenant Puget, who explored it.

* Named by the United States Exploring Expedition, 1841.

STEILACOOM.

On the eastern shore of Puget's Sound, 9 miles south of Point Defiance, is situated the town or village of Steilacoom, upon a rising bluff. It consists of only a few houses. Fort Steilacoom stands about a mile inland, upon a piece of gravelly prairie, and roads lead from it to the town and the creek.

The neighboring country is only moderately well adapted to agriculture, except along the bottoms of the small streams.

The usual anchorage is off the small wharf, in 15 fathoms, hard bottom, and about 400 or 500 yards from the shore. An island, lying $2\frac{1}{4}$ miles distant to the west of that position, is called McNeil, and between it and Fox island, to the northward, there is a passage a mile and a half wide. The passage on the south side of McNeil island, between it and Anderson island, is generally known as Balch's Passage. It bears about SW. by W. from the anchorage, and is marked by a small wooded islet in it called Eagle island, off which lies rocky bottom, and vessels keep closer to the north shore. This passage is the direct channel to Olympia, instead of following the broad one to the southward of Steilacoom.

The north end of the island showing to the southward, and $1\frac{1}{2}$ mile from the anchorage, is Kitson island.

One mile north of the anchorage is the mouth of a small stream called the Steilacoom river.

In coming to Steilacoom, or bound direct for Olympia, a patch of kelp, with foul bottom and less than 3 fathoms of water upon it, must be avoided. It bears S.SE. one mile from the south end of Fox island, and NW. by W. $1\frac{3}{4}$ mile from Steilacoom wharf. The tide-rip upon it and abreast of the town is very great, quite sufficient with a little wind to swamp a small boat. The shores of the main and islands are bold, nearly uniform in height, and covered with trees.

Tides.—The corrected establishment or mean interval between the time of the moon's transit and the time of high water is IV*h.* XLVI*m.* The mean rise and fall of tides is 9.2 feet; of spring tides 11.1 feet, of neap tides 7.2 feet. The mean duration of the flood is 6*h.* 3*m.*, of the ebb 6*h.* 25*m.*, and of the stand 28*m.* The difference between the rise of the highest tide and fall of the lowest tide observed was 18.3 feet. The greatest difference observed between the height of the two low waters of one day was 12.2 feet; and the greatest difference between the higher high and lower low waters of a day was 17.7 feet.

When the moon's declination is greatest north, the two high waters of the day follow her transit, respectively, by about 6 and 16 hours, and when greatest and south by $3\frac{1}{2}$ and $18\frac{1}{2}$ hours, the height of the two being about equal. When the moon's declination is zero, they follow the moon's transit by about 4*h.* 46*m.* and 17*h.* 12*m.*, but the first is higher than the second by about 2.7 feet when the moon's declination is changing from north to south, and when changing from south to north the second is higher than the first by that quantity. When the moon's declination is greatest, north or south, the two low waters follow the moon's transit by about 11*h.* 11*m.* and 33*h.* 37*m.*, but when north the second falls lower than the first by about 9.7 feet, and when south the first falls lower than the second by that quantity. When the moon's declination is zero, the two low waters are nearly equal in height; when changing from north to south they follow the moon's southing by about 11*h.* 41*m.* and 23*h.* 7*m.*, and when changing from south to north by 10*h.* 41*m.* and 24*h.* 7*m.*

The pronunciation of the name Steilacoom, as given to us by Indians, is Tchil′-æ-cum. On the Admiralty maps we find it Chelakoom.

Nisqually, 5 miles south of Steilacoon, and on the same side of the Sound, is, at present, a place of no trade nor importance. It was one of the early posts of the Hudson Bay Company, and is still occupied by them. An extensive mud flat exists off the mouth of the wide, marshy valley, but the depth of water is very great close to it, and the anchorage room very much contracted. The river Nisqually empties here, and we believe there are two small saw-mills upon it.

OLYMPIA.

It would be almost useless to attempt to describe the route to Olympia from Steilacoom, as a pilot or a map is absolutely necessary in making the passage. The mid-channel course is 21 miles in length, and its width from half a mile to a mile and a half.

Olympia is situated at the head of Budd's inlet, which is 6 miles long, three-quarters of a mile wide, and runs nearly south. The shores are steep and wooded, and the head of the bay an immense mud flat, behind which is the town. It acquires prospective importance by being the capital of the Territory, but especially on account of its proximity to the Columbia river valley, and to the headwaters of the Chehalis. There is a saw-mill at New Market, 2 miles south on the Tumwater, and three others in the vicinity, besides one or two grist-mills.

A depth of 3 fathoms can be carried on the west side of Budd's inlet, within $1\frac{1}{2}$ mile of the wharf, and 1 fathom within a mile on the eastern side. Vessels are said to be brought up to the wharf at the highest tides, and then rest in the mud until ready to leave.

The greatest difference between the highest and lowest tides is reported about 24 feet, and is doubtless more than this when we compare its position with that of Steilacoom. The approximate corrected establishment is V*h*. VIII*m*., and the mean rise and fall of tides 9.2 feet.

The approximate geographical position of the wharf is—

	°	′	″	
Latitude	47	03	00	north.
Longitude	122	55	00	west.
	h.	*m.*	*s.*	
Or, in time	8	11	42.	

Magnetic variation 20° 47′ east, in July, 1856.

A small saw-mill has been built on Hammersley's inlet, and another on Henderson's inlet.

HOOD'S CANAL.

The entrance to this arm of Admiralty inlet, lies between Basalt Point and Foulweather Bluff, which bear from each other E. $\frac{3}{4}$ S., distant $3\frac{1}{3}$ miles.

The first mid-channel course is SE. for 4 miles, pointing directly into Port Gamble, at the entrance to which the houses and mill are plainly visible; and passing a high round wooded peninsula on the west side of the channel, and connected to the main by a narrow neck of low sand beach. It is frequently mistaken for an island, and is called Hood's Head. Between this head and Port Gamble the canal changes its course, and runs in nearly a straight line S. by W. 40 miles, with an average width of $1\frac{1}{2}$. In latitude 47° 21′ N. it makes an abrupt turn, and runs for 12 or 13 miles about NE.

PORT LUDLOW.

Close to Basalt Point lie some rocks, with others about half a mile SE., called the Colvos Rocks,* among which is one 25 feet high but of small extent. Close in shore and abreast of this is a rock just awash at high tide, but between the two runs a channel with 15 fathoms water, having soft muddy bottom. The bright bluff head 1¼ mile SE. of the Colvos Rocks, and about 2 miles SW. by W. from Foulweather Bluff, is *Tala Point.* Half way between the Colvos and this point is the usual entrance, over a bar having 4½ fathoms. The 3-fathom curve stretches half a mile SE. of Colvos. If the wind and currents do not suit for this channel, run inside of the Colvos, carrying deep water and 8 fathoms, soft, muddy bottom, anywhere inside of Tala point, even past the saw-mill, if necessary. The general direction of the shore from Basalt Point to the saw-mill on the low sand point inside is S.SE. 2½ miles. Abreast of Tala the width of the bay is three-quarters of a mile, but it gradually contracts to less than half a mile at the saw-mill, at which vessels load. Inside of the saw-mill point is an excellent anchorage in 7 and 8 fathoms. About a mile from the mill is an ample water power, with a fall of 80 feet. A hydrographic sketch of Port Ludlow was issued by the Coast Survey in 1856.

We believe the Pacific Mail Steamship Company have established a coal depot here, for their Puget's Sound steamships.

Of all the small harbors in these waters we do not hesitate to give this the preference, as it is completely land-locked, and protected from gales from every quarter by the high land and high trees around it.

It received its present name from the United States Exploring Expedition in 1841.

The first rocks off Basalt lie at the narrow mouth of a small boat harbor, called Mats-mats. The entrance to it is over half a mile long, about 100 yards wide, and at the sharp turn obstructed by rocks, which allow a channel of only 3 feet water. Inside the depth ranges to 2 fathoms, and the extent of the harbor is about three-quarters of a mile by a third in breadth.

PORT GAMBLE.

After passing Foulweather Bluff keep closer to the eastern shore than the western, to avoid the strong current passing round the low point which makes out from Hood's Head. Run for the saw-mill plainly in sight on the western side of the entrance to the bay, and when within a mile of it approach the eastern bluff within the third of a mile, in about 10 or 15 fathoms, gradually drawing closer in shore, and passing between the outer white and inner black can buoys. At the lowest tides the white one is in 15 feet, the black in 12½, and the small spar buoy between them in mid-channel in 17 feet; but it rarely shows above water at any tide. After passing these buoys the mill bears almost S.SE. half a mile distant. Steer SE. or half way between the mill wharf and the east point; pass to the east of the white spar buoy, which is in 12½ feet, and run through the entrance, passing the wharf at about one-third of the distance between the points. Do not round up to the eastward, as a shoal makes out almost parallel with the point. It may be here noticed that these buoys were made and placed by the Puget Mill Company, for the benefit of vessels trading to the port.

If the wind is ahead while beating up, it will be impossible for a large sized vessel to get in, as the channel is half a mile long, and not over 100 yards wide at the narrowest part. Anchor off the buoys and drop in with the early flood, or warp in with the last of the ebb. On the shoal forming the western side of it 10 feet may be found until up with the white spar buoy.

* Named by the United States Exploring Expedition.

Inside of the points the bay appears to open well under the eastern one, but the 3-fathom curve makes out on a line with the end of the point. On the western side is a crib—anchor just beyond it in 5 fathoms, soft muddy bottom. The depth of water throughout the bay is from 4 to 9 fathoms, in mud bottom. The length of the bay is $2\frac{1}{4}$ miles, its width three-quarters of a mile, and its direction southeast. The shores are steep but not high, and are bordered by sand and pebble beach, offering capital chances for laying a vessel out. A better place, however, for that purpose, is at the end of the store wharf, especially for vessels with large dead rise.

In summer the wind generally blows into the harbor lightly; in winter the SE. gales draw directly out. Loaded vessels must warp out in summer, or trust to a light southerly air in the morning with an ebb tide. None but small, smart working vessels can beat out, and few of those have done so within the channel limits.

The Coast Survey Report for 1856 contained a hydrographic sketch of Port Gamble.

The approximate geographical position of the eastern point of the entrance is:

	°	′	″	
Latitude	47	51	32	north.
Longitude	122	33	56	west.
	h.	*m.*	*s.*	
Or, in time	8	10	15.7.	

The saw-mill here is the largest and most effective in this part of the territory, cutting at the rate of six or seven millions of feet of lumber per year. Attached to it are lath, shingle, and planing machines. A large quantity of the lumber and rough spars for masts are carried to Australia and the Sandwich Islands. Within two or three seasons, ending with that of 1857, the number of outward bound vessels trading to the Sandwich Islands was 15; the average passage $26\frac{1}{2}$ days; the shortest passage 19 days, and the longest 32. From the islands to the mill the number of vessels arriving was 16; average passage $25\frac{1}{2}$ days; shortest passage 15 days, and the longest 35 days. Of these, one reported a passage of 15 days to the mouth of Fuca strait, and 9 days thence to the port, in the early part of September, having encountered prevailing calms in the strait and inlet.

From this place, called Teekalet, (the Indian name for the bay,) a road is being constructed (1857) by the Mill Company to Port Madison.

The steam and smoke from the saw-mill are distinctly visible from part of Port Townshend over the low ground between that bay and Oak Cove.

Three miles from Hood's Head, on the western side of the canal, *Suquamish harbor* opens. A large sand bank occupies its centre, and extends a mile in length N.NW., by half a mile in width. The approaches to the shoal, which is in part bare, are detected in thick weather by the lead, the soundings decreasing regularly from 20 fathoms. Keep, however, close under the northern shore which runs 2 miles W.SW. from the low point called Termination Point.

Fourteen miles from Hood's Head the canal curves more to the southward, and then to the S.SW. around Hazel Point, * on the west side of which a large arm of the canal makes north for 10 miles, bifurcating near its head. On its western side the eastern spurs of the Olympus Range reach its waters and form the western shore-line of the canal to the great bend.

Two miles south of Hazel Point, and on the eastern side of the canal, is a fine harbor, formerly called *Hahainish harbor*, but the name has been changed by settlers, who have lately built a small saw-mill there. It is formed by Seabock island on the west, and is about a mile

* Named by Vancouver in 1792.

long by half a mile wide, with good bottom in from 10 to 15 fathoms, the depth decreasing to the head.

South of the harbor Hood's canal is slightly contracted in width, but continues in the same general direction to about latitude 47° 21′ N., ("Vancouver's farthest,") where it takes an abrupt turn and stretches E. by N. ½ N. 4 miles. The width in that part contracts to half a mile, and the shores overlap. From this it takes another slight bend, runs NE. by N. 8 or 9 miles, and reaches within 2 or 3 miles of the northern extremity of Case Inlet, an arm of Puget's Sound. A large lake lies between the inlet and the canal. When Vancouver reached the first sharp turn he thought he saw the termination of the canal, and has plotted it in accordance with that view on his chart, four miles beyond the point marked "Vancouver's farthest" on the Admiralty charts. This was, in fact, the highest point to which he carried his boats.

The name, Hood's Canal, was given to it in 1792 by Vancouver. Its extent of shore-line is not less than 192 miles.

Before quitting our undertaking we are induced to append the following meteorological table, as it will give a good idea of the summer climate. The observations were made upon a vessel in the waters of Fuca Strait, Admiralty Inlet, and Puget's Sound; the instruments being kept in the best shade practicable. The barometer was an aneroid: read at the hours 10 a. m. and 4 p. m., except in heavy weather, when it was read every hour. The thermometer readings are on the Fahrenheit scale and reduced to the standard.

Abstract of meteorological observations made on board the United States Coast Surveying brig R. H. Fauntleroy, in the Strait of Juan de Fuca, Archipelago de Haro, Admiralty Inlet, and Puget's Sound, during the summers of 1855, '56, *and* '57.

Time.	Means of daily maxima.	Means of daily minima.	Highest readings, maxima.	Range of maxima.	Lowest readings, minima.	Range of minima.	Greatest range of temperature in one day.	Range of barometer, inches.	Rain, inches.
	°	°	°	°	°	°	°	*Inches.*	*Inches.*
1855.—July	71.5	53.3	90.9	29.9	48.2	9.4	33.7	0.44	Not measured.
August	70.2	53.4	83.3	24.7	49.8	6.6	29.7	.43	
September	65.8	52.5	77.7	18.3	49.3	8.6	20.0	.91	
Three weeks in October	63.2	52.2	76.7	20.2	45.3	11.9	27.6	.38	

Greatest range of temperature during the above period, 45°.6.

Greatest range of barometer from June 24 to October 18, = 0.92 inch.

A dry season; heavy SE. gales in September.

ABSTRACT—Continued.

Time.	Means of daily maxima.	Means of daily minima.	Highest readings, maxima.	Range of maxima.	Lowest readings, minima.	Range of minima.	Greatest range of temperature in one day.	Range of barometer, inches.	Rain, inches.
	°	°	°	°	°	°	°	*Inches.*	*Inches.*
1856.—May	67. 1	48. 7	85. 7	31. 1	45. 0	7. 4	38. 1	0. 53	Not measured.
June	69. 0	51. 2	84. 4	27. 4	45. 7	10. 3	34. 0	. 53	
July	72. 5	51. 7	84. 7	29. 7	43. 4	14. 0	41. 3	. 43	
August	72. 2	53. 5	83. 7	25. 5	48. 4	10. 2	30. 2	. 56	
September	72. 8	51. 1	85. 1	27. 5	42. 0	14. 4	36. 5	. 69	

Greatest range of temperature during the above period, 43°. 7.

Greatest range of barometer from April 25 to September 30, 0. 85 inch.

A wet season.

Time.	Means of daily maxima.	Means of daily minima.	Highest readings, maxima	Range of maxima.	Lowest readings, minima.	Range of minima.	Greatest range of temperature in one day.	Range of barometer, inches.	Rain, inches.
	°	°	°	°	°	°	°	*Inches.*	*Inches.*
1857.—Three weeks in May	71. 7	48. 4	101. 5	46. 9	38. 5	18. 1	46. 0	0. 52	0. 79
June	78. 2	50. 7	90. 1	29. 2	43. 0	13. 1	36. 9	. 62	1. 19
July	74. 9	51. 6	89. 2	26. 5	46. 9	9. 3	33. 1	. 44	0. 01
August	73. 8	51. 1	88. 0	28. 0	47. 1	9. 7	37. 8	. 46	0. 08
September	65. 5	49. 8	76. 4	23. 3	45. 2	8. 5	30. 8	. 73	0. 70
Two weeks in October	60. 1	48. 9	68. 7	16. 3	43. 4	7. 8	25. 1	. 65	0. 74

Greatest range of temperature during the above period, 63°. 0.

Greatest range of barometer from May 12 to October 13, 0. 79 inch.

A dry season; and marked by a week of remarkably hot weather at the close of May and beginning of June.

The cerealia generally grow well, but the climate is too cold for maize. During the winter a great amount of rain falls—as much as 60 inches; and heavy weather prevails principally from the southward. It is never cold enough to form thick, clear, solid ice.

Table of geographical positions of important headlands, bays, rivers, light-houses, &c., on the western coast. Compiled from the "Directory for the Pacific Coast of the United States."

EXPLANATION.—Primary astronomical stations in small capitals; secondary astronomical stations designated by the mark 2 A; light houses and light-house sites in italics, with the order of the light in Roman numerals; *F. signifies fixed; Fl., flashing; Var., varied; Rv., revolving; W., white; Rd., Red; Nat., natural color; M., minutes;* and the Arabic numerals denote the distance at which the light may be seen, under ordinary states of the atmosphere, from a height of twenty feet above the sea.

Number.	Name of station.	Locality.		Latitude, north.	Longitude, west. In arc.	Longitude, west. In time.	Magnetic variation, east.	Time of determination.
	CALIFORNIA.			° ′ ″	° ′ ″	h. m. s.	° ′	
1	Los Coronados, (belonging to Mexico)	The largest islet		32 23 46	117 13 21	7 48 53.4	....	....
2	*Point Loma light-house.* I—F. W.—29	West side of the entrance to San Diego bay, 450 feet high		32 40 13.0	117 12 22	7 48 49.5	....	....
3	SAN DIEGO	Observatory Hill, near La Playa, San Diego bay		32 41 58.0	117 13 22	7 48 53.5	12 29	April, 1851
4	San Clemente. 2 A	At the northwest extremity of the island		33 02	118 34 00	7 54 16.0	....	....
5	Cortez Shoal	Two and a half fathom spot		32 25 ¾	119 05	....	....	....
6	San Nicolas. 2 A	At the southeast end of the island		33 14 12.7	119 25 00	7 57 40.0	....	....
7	Santa Catalina. 2 A	At the great transverse break of the island, (north side)		33 26 34.8	118 28 45	7 53 55	....	....
8	*Santa Barbara island*	23 miles W. by S. from the N. end of the Santa Catalina		33 30	119 02	....	....	....
9	San Pedro bay. 2 A	Edge of the bluff at the landing		33 43 19.6	118 16 03	7 53 04.2	13 30	Nov., 1853
10	Anacapa	Eastern point of the island	Santa Barbara channel.	34 01	119 19	....	....	....
11	Prisoner's harbor. 2 A	North side of the island of Santa Cruz		34 01 10.2	119 40	7 58 40.0	....	....
12	Cuyler's harbor. 2 A	At the NE. part of the island of San Miguel		34 03	120 20 27	8 01 21.8	....	....
13	*Santa Barbara light-house.* IV—F. Rd.—12	Two miles southwestward of the landing, 180 feet		34 23 35.4	119 42 05	7 58 48.3	....	....
14	Santa Barbara. 2 A	At the landing		34 24 24.7	119 40 18	7 58 41.2	....	....
15	*Point Conception light-house.* I—Rv. W. Fl. ½ M.—23	Point Conception, 250 feet high		34 26 46.6	120 27	8 01 48.0	....	....
16	POINT CONCEPTION	Valley of El Coxo		34 26 56.3	120 25 39	8 01 42.6	13 50	Sept., 1850
17	Point Arguello	12 miles NW. by W. ½ W. from Point Conception		34 34	120 38	....	....	....
18	San Luis Obispo bay. 2 A	*At the same gully west of the creek*		35 10 37.5	120 43 31	8 02 54.1	14 17	Feb., 1854
19	San Simeon bay. 2 A	Near the landing		35 38 24.4	121 10 22	8 04 41.5	....	....
20	Piedras Blancas	White rocks near San Simeon bay, outer one		35 39	121 15	....	....	....
21	Point Sur	51 miles SE. ½ S. from Point Año Nuevo		36 19	121 52	....	....	....
22	*Point Pinos light-house.* I I—F. Nat.—13	At the NW. point of the trees, 53 feet high		36 37 58.1	121 55	8 07 40.0	....	....
23	POINT PINOS	SW. point of Monterey bay, near light-house		36 37 59.4	121 54 25	8 07 37.7	14 58	Feb., 1851
24	Santa Cruz harbor. 2 A.	At the Embarcadero, northern part of Monterey bay		36 57 26.9	122 00 10	8 08 00.7	....	....
25	Point Año Nuevo	40 miles SE. by S. from San Francisco Bar bell-boat		37 07	122 19	....	....	....
26	Point San Pedro	13 miles S. by E. ½ E. from Boneta light		37 35½	122 31	....	....	....
27	*South Farallone light.* I—Rv. W. Pr. Fl. every M.—27	23½ miles SW. by W. ½ W. off entrance to San Francisco bay, 360 ft.		37 41 55.2	122 59 05	8 11 56.3	....	....
28	*Point Lobos light-house* site	The S. head of entrance to San Francisco bay		37 46 56.9	122 29 39.5	8 09 58.6	....	....
29	Rincon Point. 2 A	NW. of South Park, San Francisco city		37 47 07.0	122 22 32	8 09 30.1	....	....
30	PRESIDIO	Near the Presidio of San Francisco		37 47 36.1	122 26 15	8 09 45.0	....	....
31	TELEGRAPH HILL	Near the "San Francisco Observatory"		37 47 59.2	122 23 19.4	8 09 32.5	15 27	Feb., 1852
32	Telegraph Hill	Triangulation station, summit of the hill		37 48 06.4	122 23 19.4	8 09 33.3	....	....
33	*Fort Point light-house.* V—F. Nat. 12½	S. side of the entrance to San Francisco bay, 53 feet		37 48 37.4	122 27 38	8 09 50.5	....	....
34	*Point Boneta light-house.* II—F. Nat.—25	N. head of the entrance to San Francisco bay, 306 feet		37 49 10.0	122 30 50.3	8 10 03.3	....	....

TABLE OF GEOGRAPHICAL POSITIONS—Continued.

Number.	Name of station.	Locality.	Latitude, north.	Longitude, west. In arc.	Longitude, west. In time.	Magnetic variation, east.	Time of determination.
	CALIFORNIA—Continued.		° ′ ″	° ′ ″	h. m. s.	° ′	
35	*Alcatraz Island light.* III—F. Nat.—14	In the harbor of San Francisco, 162 feet high	37 49 33.0	122 24 18.8	8 09 37.2	....	....
36	Punta de los Reyes. 2 A	At landing on Sir Francis Drake's bay	37 59 34.2	122 57 40	8 11 50.7	....	....
37	*Punta de los Reyes light-house* site	On the western head of the point	37 59 37.4	123 00 16	8 12 01.1	....	....
38	Bodega. 2 A	Bodega bay, W. end of Sandy Point	38 18 20.4	123 02 28.8	8 12 09.9	....	....
39	Haven's Anchorage. 2 A	On the bluff at the landing	38 47 58.0	123 34 01	8 14 16.0	....	....
40	Mendocino bay. 2 A	On the bluff near the landing	39 18 06.1	123 47 25.6	8 15 09.7	....	....
41	Punta de Arena	NW. extremity of the point	38 57	123 45	....	....	....
42	Shelter Cove, (Point Delgado.) 2 A	On the bluff near the landing	40 01 14.1	124 03 03	8 16 12.2	....	....
43	Cape Mendocino	Extremity of cape	40 25	124 22	....	....	....
44	HUMBOLDT	Red Bluff, Humboldt bay	40 44 40.2	124 12 (00)	8 16 (48)	17 04	April, 1854
45	*Humboldt light-house.* N. F. W.—13½	On the N. point, one mile from entrance, 53 feet	40 46 03.6	124 12 21	8 16 49.4	....	....
46	Bucksport. 2 A	Town of Bucksport, Humboldt bay	40 46 37.1	124 10 44	8 16 42.9	17 06	July, 1853
47	Trinidad. 2 A	Town of Trinidad, Trinidad bay	41 03 20.0	124 08 08	8 16 32.5	....	....
48	*Crescent City light-house.* IV—F. W. Var. by Fl.—15½	On the extreme W. part of the point, 80 feet high	41 44 34.2	124 11 22	8 16 45.4	....	....
49	Crescent City. 2 A	W. of the town, near Point St. George	41 44 44.0	124 11 14	8 16 44.9	....	....
	OREGON TERRITORY.						
50	Port Orford. 2 A	In the town of Port Orford, near the landing	42 44 28.2	124 28 52.2	8 17 55.5	....	....
51	PORT ORFORD	On the bluff W. of the town	42 44 21.7	124 28 47	8 17 55.2	18 29	Nov., 1851
52	Cape Orford or Blanco	Extremity of the cape	42 50	124 30	....	....	....
53	Cape Gregory	NW. part of the cape off Koos bay	43 20	124 19	....	....	....
54	*Umpquah River light.* III—F. W.—16½	On the S. side of the river, at its mouth, 100 feet	43 40 18.5	124 11 03	8 16 44.2	....	....
55	Umpquah. 2 A	One mile from the entrance to the river, (W. side)	43 41 45.0	124 09 57	8 16 39.8	....	....
56	Cape Perpetua	Middle part of the headland	44 19	124 06	....	....	....
57	Cape Foulweather	Southern part of the cape	44 45	124 04	....	....	....
58	Cape Lookout	Sharp point furthest W.	45 20	124 00	....	....	....
59	Cape Meares	NW. part. The Cape Lookout of Meares and Vancouver	45 30	123 58	....	....	....
60	Cape Falcon, or False Tillamook	Northern part	45 47	123 58	....	....	....
61	Tillamook Head	SE. by S. ¾ S., 19 miles from Disappointment light	45 58	123 59	....	....	....
62	Astor Point	Near Astoria, Columbia river	46 11 27.6	123 49 31.7	8 15 18.1	....	....
63	Point Adams	South Point, entrance to Columbia river, half a mile inside	46 12 30.4	123 56 55.8	8 15 47.7	....	....
	WASHINGTON TERRITORY.						
64	*Cape Disappointment light-house.* I—F. W.—22½	Near the highest part of the cape	46 16 32.7	124 02 13	8 16 08.9	....	....
65	CAPE DISAPPOINTMENT	North Point, entrance to Columbia river, highest part	46 16 35.2	124 02 01	8 16 08.1	20 45	July, 1851
66	Leadbetter Point	S. point of the entrance to Shoalwater bay	46 36 (45)	124 00 (45)	8 16 (03)	....	....
67	Point Grenville	Point of the bluff at the anchorage	47 20 (00)	124 14 (00)	8 16 (56)	....	....

TABLE OF GEOGRAPHICAL POSITIONS--Continued.

Number.	Name of station.	Locality.	Latitude, north.	Longitude, west. In arc.	Longitude, west. In time.	Magnetic variation, east.	Time of determination.
	WASHINGTON TERRITORY—Continued.		° ′ ″	° ′ ″	h. m. s.	° ′	
68	Destruction island	Nort Point	47 41	124 25			
69	Flattery Rocks	Northwestern rocky islet	48 12	124 43	....	....	....
70	**Tatoosh Island light-house.* I—F. W.—20	Off Cape Flattery, Strait of Juan de Fuca	48 23 15.5	124 43 50	8 18 55.3	21 30	Aug., 1852
71	NEE'-AH BAY	Near the creek, in Neé-ah bay, Strait of Juan de Fuca	48 21 48.8	124 37 12	8 18 28.8	21 47	Aug., 1855
72	Port Angelos. 2 A	Head of the bay, Strait of Juan de Fuca	48 07 51.5	123 27 21	8 13 49.4	....	....
73	*New Dungeness light-house.* III—F. W.—18½	On the end of the Sand Point, Strait of Juan de Fuca	48 10 59.0	123 06 07	8 12 24.5	....	....
74	*Smith's Island light-house site*	SW. point of the island	48 19 11.0	122 50 01	8 11 20.1	....	....
75	Point Wilson	W. point of entrance to Admiralty inlet	48 08 42.7	122 44 49.4	8 10 59.3	....	....
76	Point Hudson. 2 A	In Port Townshend, extremity of the point	48 07 03.0	122 44 33	8 10 58.0	21 40	Aug., 1856
77	Admiralty Head	E. side of entrance to Admiralty inlet	48 09 21.6	122 40 08	8 10 40.5	....	....
78	Port Gamble	Four miles inside the entrance to Hood's canal, East Point	47 51 32.0	122 33 56	8 10 15.7	....	....
79	Restoration Point. 2 A	SE. point of *Bainbridge* island	47 35 05.8	122 28 15.2	8 09 53.0	....	....
80	Point Pully. 2 Ap	E. side of Admiralty inlet, opposite Vashon's island	47 27 07.3	122 22 21.5	8 09 29.4	....	....
81	Lummi. 2 A	Sand point on the NE. side of the island	48 44 01.7	122 40 37	8 10 42.5	....	....
82	Lummi North	N. point of the island	48 44 53.2	122 42 12	8 10 48.8	....	....
	VANCOUVER ISLAND.		From	the Admiralty	charts.		
83	Observatory Rocks	SE. point of San Juan harbor, Strait of Juan de Fuca	48 31 30	124 28 15	8 17 53.0	....	....
84	Beechy Head	E. of Sooke inlet, Strait of Juan de Fuca	48 18 30	123 39 27	8 14 37.8	....	....
85	Race islands	Southernmost point of Vancouver, Strait of Juan de Fuca	48 17¼	123 32	....	....	....
86	Fishguard island	W. side of entrance to Esquimault harbor, Strait of Juan de Fuca.	48 25 38	123 27 10	8 13 48.7	....	....

* Rock Duncan bears N. 33° W. (magnetic) from Tatoosh Island light, distant 1.02 mile.

APPENDIX No. 45.

Letter to the Secretary of the Treasury, communicating a recommendation from Commander James Alden, U. S. N., Assistant Coast Survey, of Red Bluff, Washington Territory, as a site for a light-house.

SAVANNAH, GA., *April* 17, 1858.

SIR: I have the honor to present, in accordance with directions contained in a letter of the department dated November 29, 1856, the conclusion reached by Commander James Alden, U. S. N., Assistant Coast Survey, in the matter of choice between Red Bluff, on Whidbey's island, W. T., and Point Wilson, on the main, at the entrance of Admiralty Inlet, as locations for a light-house.

The last named point was suggested as an eligible site in a letter addressed by Commander S. Swartwout, U. S. N., to the chairman of the Light-house Board, under date October 18, 1856, a copy of which was communicated to the department December 20, 1856,* and from thence referred to me.

In reference to the whole subject of a light for the entrance to Admiralty Inlet, Commander Alden says:

"After carefully considering the question of eligibility between the two points, Point Wilson and Point Partridge, or Red Bluff, for a site for a light-house at the entrance of Admiralty Inlet, I am clearly satisfied that Red Bluff has decided advantages over that of Point Wilson, although the latter, at the south point of the entrance, is rather a low sand spit, with foul ground and dangerous eddies near it.

"The former, *Red Bluff*, is so situated that it can be seen either way, down the inlet or up the strait, at a great distance, and therefore is the more desirable of the two as a site for a light-house."

I concur in the conclusion drawn by Commander Alden, and respectfully request that a copy of this communication may be forwarded to the Light-house Board.

Very respectfully, yours,

A. D. BACHE, *Sup't U. S. Coast Survey.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

* Appendix No. 85, C. S. Report for 1857.

APPENDIX No. 46.

Aids to navigation, recommended in reports made to the Superintendent by Assistants in the Coast Survey.

Sec.	Object.	By whom recommended.	Date of report, &c.
I	Small light and fog-bell on Half Way Rock, Casco bay, Me.	Lieut. Comg. W. G. Temple, U. S. N.	Referred to the Light-house Board September 20, 1858.—(Appendix No. 47.)
I	Buoy for a dangerous rock off the entrance of Portsmouth harbor, N. H.	Lieut. Comg. Alexander Murray, U. S. N.	Referred to the Light-house Board September 10, 1858.—(Appendix No. 10.)
I	Buoy to mark the extremity of a sand spit south of Sunken ledge, Boston harbor.	Lieut. Comg. W. G. Temple, U. S. N.	Referred to the Light-house Board October 18, 1858.—(Appendix No. 11.)
II	Buoys to mark the Luddington Rocks and a shoal near New Haven light-house.	Lieut. Comg. W. G. Temple, U. S. N.	Referred to the Light-house Board September 13, 1858.—(Appendix No. 12.)
VI	Beacon for the "Elbow" Florida reef-------	Lieut. Comg. W. G. Temple, U. S. N.	Referred to the Light-house Board December 18, 1857.—(Appendix No. 48.)
VII	Lights on Southwest cape and Dog island, St. George's sound, Fla.	Lieut. Comg. J. K. Duer, U. S. N.	Referred to the Light-house Board May 18, 1858.—(Appendix No. 16.)
VII	Buoys for a channel between St. George's and St. Vincent's islands.	Lieut. Comg. J. K. Duer, U. S. N.	Reported May 5, 1858.—(Appendix No. 17.)
VII	Beacon on the eastern end of St. Vincent's island, St. George's sound, Fla.	Lieut. Comg. J. K. Duer, U. S. N.	Referred to the Light-house Board April 12, 1858.—(Appendix No. 49.)
X	Buoys to mark the channel from San Mateo Point southward, San Francisco bay, Cal.	Lieut. Comg. R. M. Cuyler, U. S. N.	Referred to the Light-house Board March 20, 1858.—(Appendix No. 50.)

APPENDIX No. 47.

Letter to the Secretary of the Treasury, transmitting for the consideration of the Light-house Board recommendations made by Lieut. Comg. W. G. Temple, U. S. N., Assistant Coast Survey, for a small light and fog-bell on Half Way Rock, Casco bay.

BANGOR, MAINE, *September* 20, 1858.

SIR: Lieut. Comg. W. G. Temple, U. S. N., Assistant in the Coast Survey, who has been engaged in the survey of Casco bay during the past two seasons, recommends the establishment of a light of the sixth order, and of a fog-bell, on Half Way Rock, in the following statement:

"By reference to a chart of Casco bay you will see that Half Way Rock is a small detached island lying about midway between Portland light and Cape Small Point, and directly in the track of vessels coming from the eastward to this port. Indeed, the steamers from Bangor and elsewhere in that direction pass indifferently on the outside or inside of it, and at pistol-shot distance from it.

"It will appear also, when my work for the present season shall have been plotted, that the soundings give no indication of an approach to this rock, and that its sides are very abrupt in every direction. I have found, too, that the set of the tide and the current caused by the wind are of considerable strength in this vicinity, and quite irregular in their action.

"From these considerations it will be evident that in a fog or snow storm, or at night, this locality is of a very dangerous character.

"But, with all the caution that the circumstances would naturally inspire in those who navigate these parts, there have been four vessels run upon this spot within fifteen years past, and in every case the vessels and almost the entire crews were lost. No longer ago than last summer the Bangor steamer, Daniel Webster, ran upon the rock, and she presents the only instance of a vessel having struck there and still being in existence; but by means of her machinery alone she managed to get away some three miles distance to a shelving beach, where she ran ashore barely in time to save herself from sinking."

I would respectfully request that this letter may be forwarded for consideration to the Light-house Board.

Yours, respectfully,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 48.

Letter to the Secretary of the Treasury, and correspondence relative to the necessity for a beacon on "The Elbow," Florida reef.

COAST SURVEY OFFICE, *December* 18, 1857.

SIR: I would respectfully request that the attention of the Light-house Board may be called to the desirableness of a beacon formerly recommended for Elbow key, Florida,* and transmit, on this subject, copies of a letter from Capt. Gray, of the steamship Star of the West, and of Lieut. Comg. W. G. Temple, U. S. N., Assistant in the Coast Survey, to be transmitted with my recommendation.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

STEAMSHIP "STAR OF THE WEST,"
New York, November 20, 1857.

SIR: I have to acknowledged the receipt of two charts, (one of "Key West Harbor," and the other the "Florida reefs from Key Biscayne to Pickle reef,") forwarded me by you from the Coast Survey Office.

A copy of that of "Key West" I have had for some time, and derived much benefit from it on a former voyage, when entering that harbor for the first time, at twelve o'clock at night, without a pilot, in command of the United States mail steamship Philadelphia.

On the last voyage of this ship, bound to Aspinwall *via* Havana, I struck on "Elbow key." After passing "Carysfort" light-tower, I shaped a course to pass the same distance outside of Beacon H, being unaware that there existed any shoal but what was some distance inside of

*C. S. Reports, 1855, p. 161; 1856, p. 66.

that line. On approaching Beacon H I discovered the green water under the bow, and had just time to stop the engine, and thereby save the ship. I was running by Blunt's general chart of the coast, upon which the Florida reefs are not very plainly laid down. If "Elbow key" is laid down it is very imperfectly so.

Had I been in possession of the *Coast Survey* chart of that portion of the Florida reef, the accident would not have happened, as the key, as well as the reefs, are distinctly marked. This is the second ship belonging to the United States Mail Steamship Company striking on the same spot within two months of each other, and I have since learned that the steamship "Crescent City" was on the same reef three years ago. All these ships were without the Coast Survey Chart.

I should think it might be well to place a beacon on "Elbow key," as Beacon H stands so far inside of it, and I learn from conversations since had with old and experienced shipmasters that it is the general impression that you can run from one beacon to the other.

I remain your obedient servant,

ALFRED G. GRAY.

Lieut. A. P. HILL, *U. S. A.*,
Acting Assistant in charge of Coast Survey Office, Washington.

U. S. COAST SURVEY OFFICE,
Washington, D. C., November 23, 1857.

SIR: Agreeably to your letter of the 18th instant, I have examined the Coast Survey Chart of the Florida reefs, in connection with the suggestion of Capt. Alfred G. Gray, contained in his letter of the 15th instant, to Lieut. A. P. Hill, U. S. A.

I am most decidedly of the opinion of Captain Gray, that "it would be well to have a beacon placed on Elbow key." In its absence the beacon on Grecian shoal is likely to mislead and endanger a vessel while skirting along the edge of the reef.

Respectfully,

W. G. TEMPLE, *Lieut. U. S. N.*,
Commanding Coast Survey steamer "Corwin."

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 49.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey, for a permanent beacon at the western entrance of St. George's sound, Florida.

SAVANNAH, GA., *April* 12, 1858.

SIR: I have the honor to communicate, for the consideration of the Light-house Board, an extract from a report recently made by Lieut. Comg. J. K. Duer, U. S. N., Assistant in the Coast Survey, at present engaged in the hydrography of St. George's sound, Florida:

"The Coast Survey signal situated on the easternmost point of St. Vincent's island, at the

West Pass of St. George's sound, has been made a beacon, and may be used as a guide by vessels drawing less than eleven feet water.

"I would respectfully suggest that this point be marked in a permanent manner, so that the beacon may be replaced if washed away in a gale, an occurrence by no means unlikely, as it is situated on a low sand beach. A durable beacon erected here would be very serviceable to coasters as well as to the pilots of the place.

"The directions hereto appended, if strictly observed, will carry vessels of the above limit of draught safely in, thus saving the time and distance unavoidable in following the regular channel.

"*To enter West Pass, St. George's sound, with vessels drawing less than eleven feet water.*—With the light-house on Cape St. George bearing east, (by compass,) and when in four or four and a half fathoms, bring the beacon on St. Vincent's island to bear northeast, and run directly for it until the light-house bears southeast by east, with the beach of St. Vincent's island close aboard; then haul up east by north, keeping on this course until inside both points of the entrance. Here vessels may anchor in from three to three and a half fathoms, with good holding ground.

"The beacon is white, and can readily be seen at the distance necessary to get the bearing. It is of the form of a pyramid, and neither of the pilots ranges (which are of entirely different shape, and stand considerably to the westward) must be mistaken for it."

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 50.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. R. M. Cuyler, U. S. N., Assistant in the Coast Survey, for buoys to facilitate navigation in the southern part of San Francisco bay, California.

COAST SURVEY OFFICE, *March* 20, 1858.

SIR: I have the honor to communicate the following extract from a report, made under date of February 19, by Lieut. Comg. R. M. Cuyler, U. S. N., Assistant in the Coast Survey, relative to facilities for navigation in the southern part of San Francisco bay, California:

"I would suggest that the channel from San Mateo Point to the head of the bay be buoyed out. Without such aid the large number of vessels which navigate the headwaters of the bay find it difficult in thick weather to keep in deep water. The lead is no guide, the shores of the channel being very abrupt, as will be seen by reference to the chart.

"In addition to the sailing vessels, there is a daily steamer between San Francisco and Alvise.

"Small spar buoys might be used or piles driven."

Concurring in the recommendation of Lieut. Comg. Cuyler, I transmit herewith a tracing from his hydrographic sheet, showing the channel referred to, and would respectfully request that it may be forwarded to the Light-house Board, with a copy of this communication.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

INDEX TO SKETCHES AND DIAGRAMS.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.